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Power for Tanning

GENERATION OF ELECTRIC ENERGY A BY-PRODUCT AT NEW NORTH WORKS OF WILDER TANNING CO.; ALL ELECTRIC EQUIPMENT UNDER REMOTE CONTROL

MANUFACTURING PROCESSES employed in many of the industries require such comparatively large quantities of both low- and high-pressure steam in addition to that ordinarily employed in heating and domestic service, that with proper design and operation the generation of electric energy may be considered a by-product. Particularly is this true in the case of tanneries and as a consequence, we find them included in that extensive field in which the central station can not successfully and legitimately compete with the isolated power plant. It is not in the least surprising, therefore, that when plans were drawn for the construction of the new North Works of the Wilder Tanning Co., located at Waukegan, Ill., provisions were made for steam and electric power generating equipment.

Housed in a separate structure of steel, concrete and brick, with the exterior conforming to the style of architecture employed throughout the works, the power house has been placed directly south of the main building. And while the greater portion of steam and electric

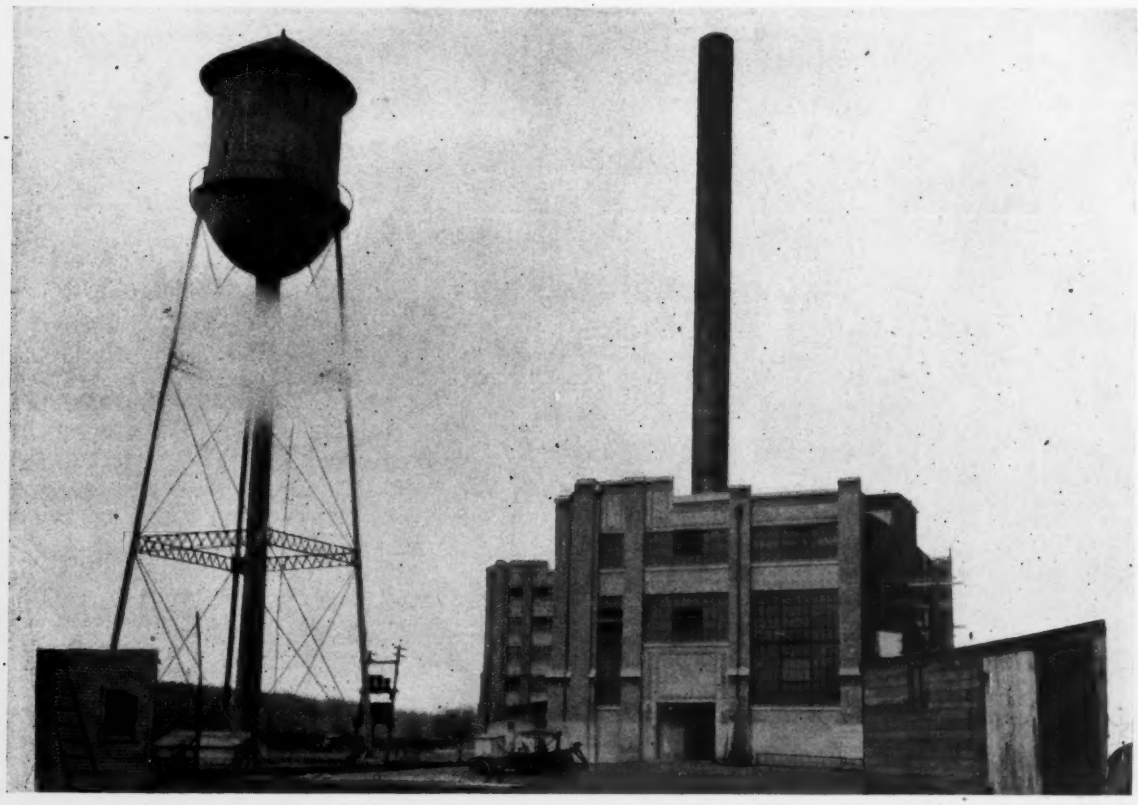
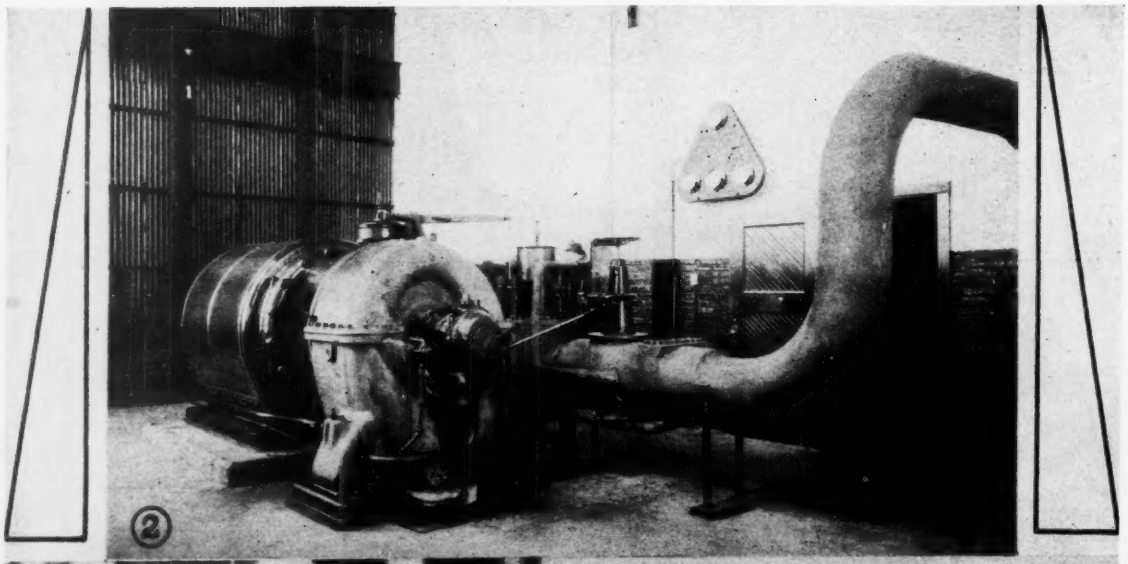


FIG. 1. POWER PLANT AND SPRINKLER WATER SUPPLY TANK OF WILDER TANNING CO.



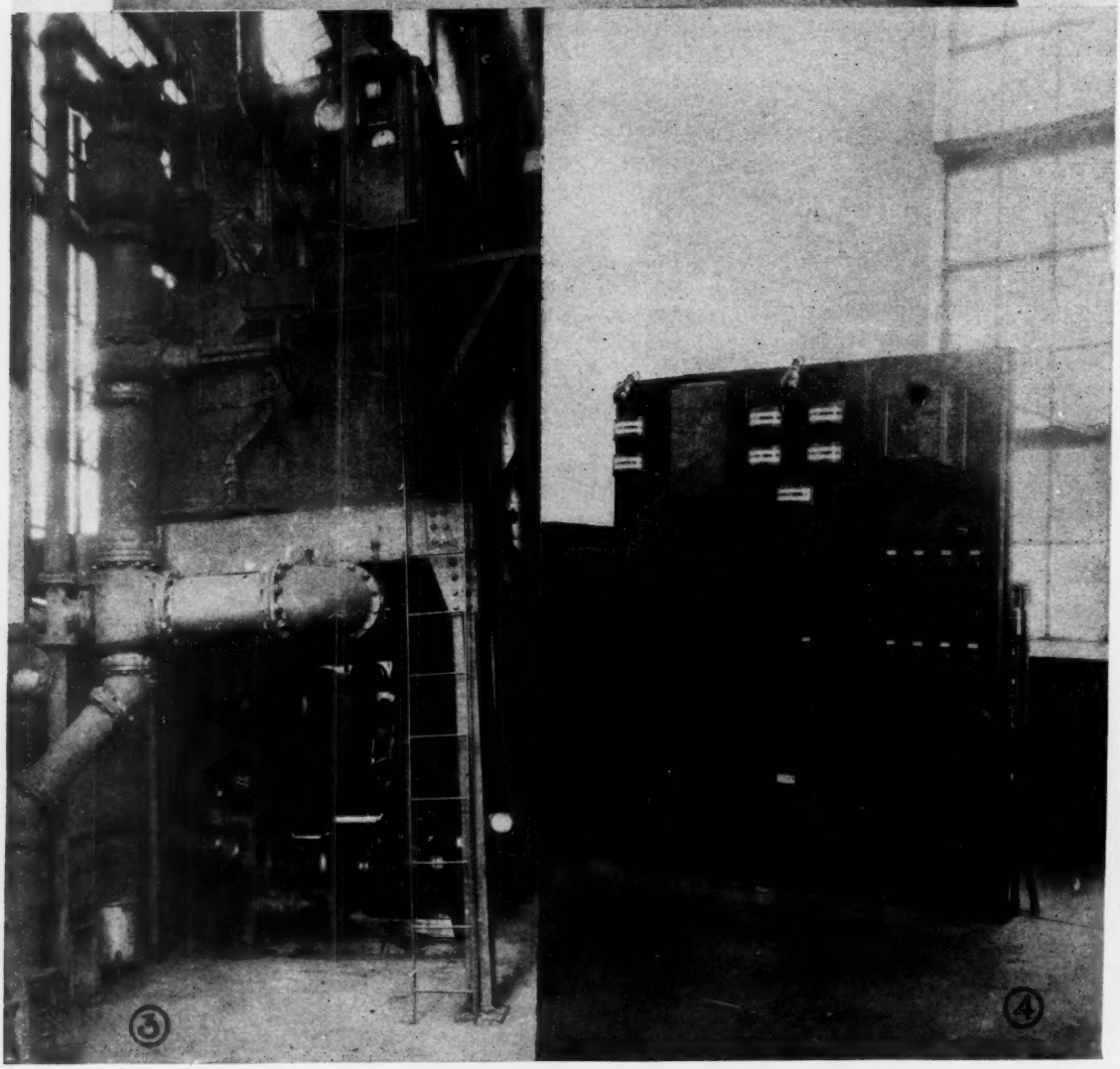


FIG. 2. THE MAIN GENERATING UNIT, A 1000-KV.A. TURBO-ALTERNATOR

FIG. 3. BOILER FEED PUMPS AND HEATER FIG. 4. MAIN GENERATOR AND DISTRIBUTION BOARD

power generated is at the present time carried north, ultimate plans calling for future extensions to the tannery will place the power plant at the approximate center of load and will thereby tend to reduce steam and electric distribution line losses to a minimum.

Due to the sandy nature of the soil in the vicinity, machine and building foundations are built upon piles driven to a depth of approximately 30 ft., and covered with concrete caps. The building, which has overall dimensions of about 81 ft. 4 in. by 47 ft. 4 in., is divided into 2 sections separated by a party wall, the larger of these sections housing the steam generating equipment and some auxiliaries, and the smaller the electric generating equipment. In the basement are vacuum heating, house service and reserve boiler feed pumps and the remotely-controlled electrical switching equipment.

Any extensions which may in the future be made to the plant will be carried to the east and to facilitate carrying on the work of any such addition the wall on this side is of temporary nature, consisting of corrugated sheet iron supported on a framework of steel.

Entering the main door to the boiler room on the south side of the building, the visitor finds 2 large 500-hp. Stirling water-tube boilers which supply all steam for power, heating and manufacturing purposes. The pressure carried in these boilers is ordinarily maintained at about 160 lb. gage, but before leaving the boilers, the steam is passed through B. & W. superheaters in which it is superheated 100 deg. F. (55.5 deg. C.). Eight-inch leads from each unit then conduct the steam to a 12-in. header supported along the boiler room wall and to which in turn is connected an 8-in. branch for the turbine supply, a 4-in. extension forming an auxiliary header for boiler feed, house and vacuum pumps and a 6-in. connection to the low-pressure mains for use when more steam than that supplied by the exhaust is required. A 4-in. Boylston high-pressure pilot reducing valve is installed at this point to reduce the pressure from that carried by the boilers to about 8 lb.

Water used for boiler feed purposes consists of returns from the heating system, that returned from such manufacturing processes as leave the water fit for re-use, and makeup taken from the city water mains. This is delivered to a Webster feed-water heater capable of raising the temperature of 200,000 lb. per hr. from 50 to 212 deg. F., and equipped with a Lea V-notch recording meter; general arrangement of this apparatus is shown in Figs. 3 and 5.

Leaving the heater, the water flows into a 6-in. main suction line and from there through 3-in. branches to either one of 2 centrifugal boiler feed pumps having rated capacities of 250 gal. per minute and driven at a speed of 3800 r.p.m. by 35-hp. American-Kerr turbines. These pumps then discharge into a 5-in. main feed line carried along the front of the boilers with 2½-in. leads connecting with the rear steam drum of each unit, the feed being under manual control.

Main boiler and water back blowoffs tie in with a 4-in. blowoff header emptying into a nearby swamp. Each blowoff branch is provided with one 2½-in. standard B. & W. blowoff valve, and one Homestead asbestos packed cock of like size.

Coal and Ash Handling Equipment

While original specifications called for the installation of large overhead steel bunkers for the storage of coal, the pressing need of the plant at the time the works were placed in operation required temporary abandonment of these plans and instead each boiler has been equipped with its individual steel hopper having a capacity of approximately 10 tons. Coal is delivered to the plant by cars run on a siding along the east side of the building and dumped into a pit from whence it is picked up by a bucket conveyor having a capacity of 15 tons an hour and distributed to the hoppers. From there the fuel is fed through spouts to the furnaces, which are equipped with Green inclined traveling chain grate stokers operated by a 3-hp. electric motor.

Carried over the rear end of the grates, the ashes are dumped into a receiving pit from which they are removed by hoes into wheelbarrows which are wheeled onto the platform of a 2000-lb. Otis hydraulic elevator and raised to the ground level, the ashes being used in a nearby fill.

Electric Generating Equipment

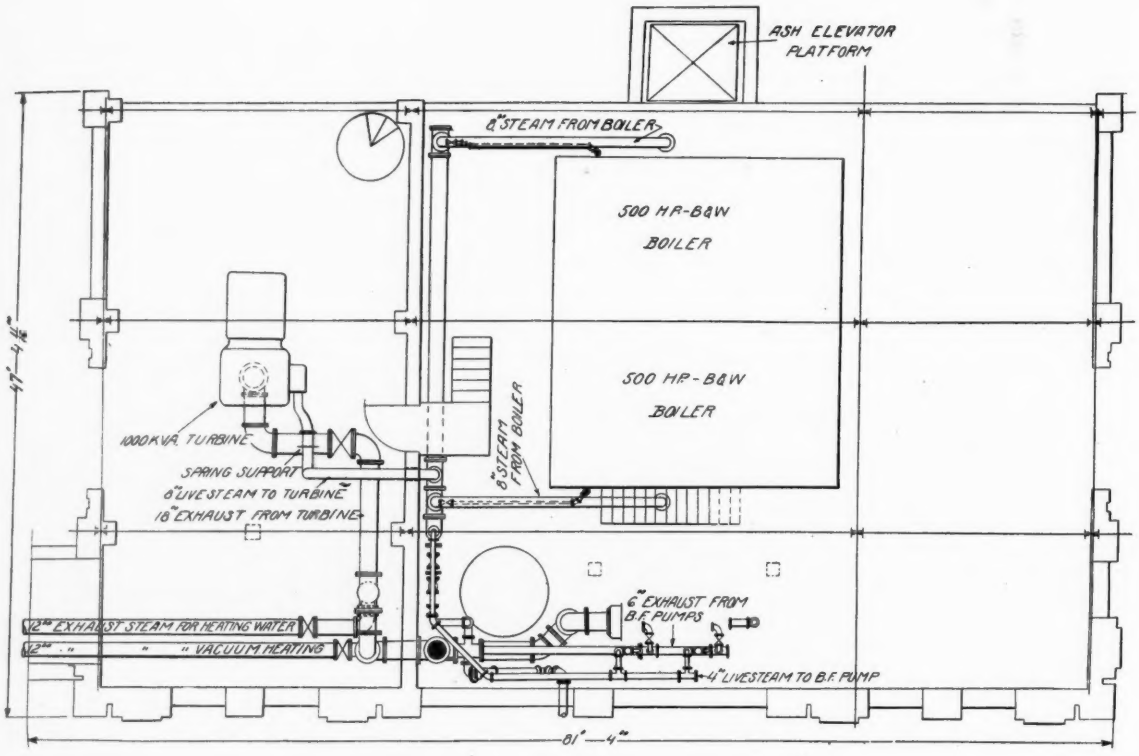
Due to unexpected increases in business and consequent installation of extra machinery, the main generating unit, consisting of a 1000-kv.a., 440-v., 3-phase, 60-cycle General Electric horizontal turbo-alternator, is already carrying loads in excess of its rated capacity, although the present connected lighting load is only 100 kw. and the motor load but 750 hp. The motors range in size from that of the smallest at 3 hp. to the largest at 35 hp.; these are operated at 440 v.

Remotely electrically controlled oil switches are employed and are grouped and mounted on a substantial steel framework in the basement of the turbine room. The largest of these, however, having a capacity of 1500 amp. at 4500 v. and used to isolate the main generator, is installed separately, directly below the machine. Current for the operation of these switches is taken directly from the exciter bus bars and though, due to the operation of a Tirrill voltage regulator, the voltage across these bus bars varies from 75 to 140 v., positive and instant operation of the switches may be depended upon at all times. Control of all this equipment is from a black slate switchboard built up of one regulator panel, one exciter panel, one generator panel and one distribution panel and in addition to the switching equipment and Tirrill voltage regulator, this board also carries exciter and machine rheostats and inverse time limit overload relays for each outgoing circuit.

As stated before, the plant is already operating under excessive overloads and in order to relieve the situation at least temporarily until the necessary additional equipment may be installed, standby service is being at present obtained from the lines of the Public Service Co. of Northern Illinois. An additional panel and the necessary switching equipment for this is now being installed.

General Water Supply

Water for boiler feed, process, house and fire service is obtained from the city mains through an 8-in. supply line, while that for drinking purposes is drawn from a driven well and delivered to bubblers throughout the works by one of two Bishop and Babcock pumps operated by city water. These pumps are run alternately, one days and the other nights.



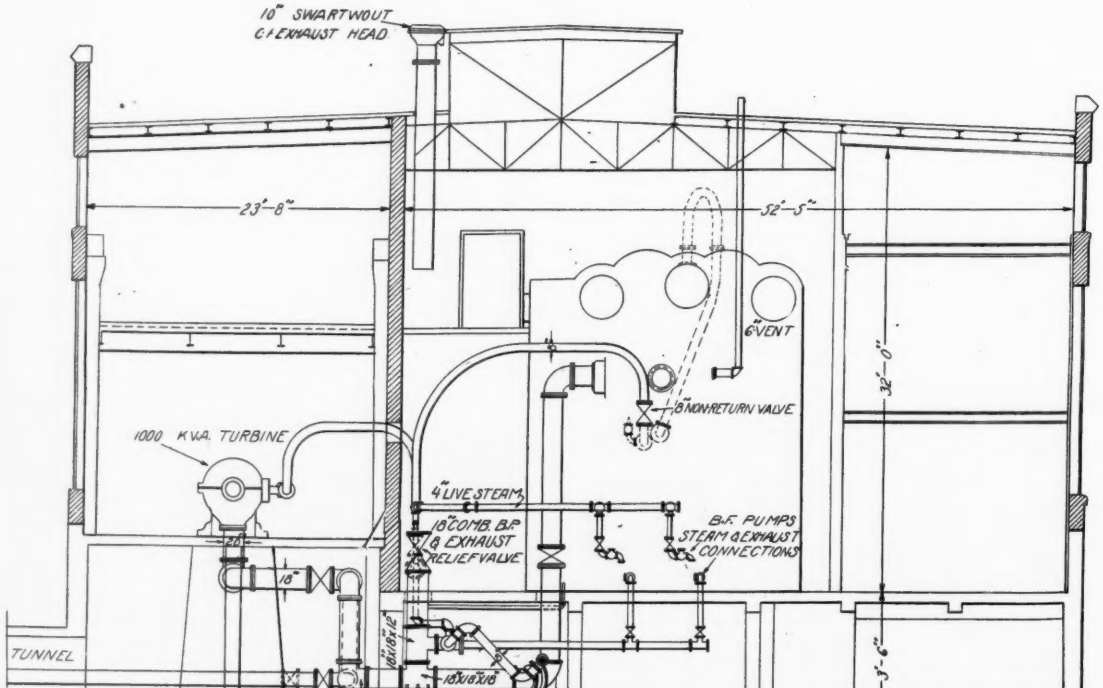


FIG. 5. PLAN AND ELEVATION OF POWER PLANT

The sprinkler system is of the wet type and connects with a 180,000-gal. steel tank mounted on a framework of structural steel located adjacent to the power plant as shown in Fig. 1. This tank in turn receives its supply from the city water mains, thus rendering the sprinkler system entirely independent of the power plant and to considerable extent independent of the city supply.

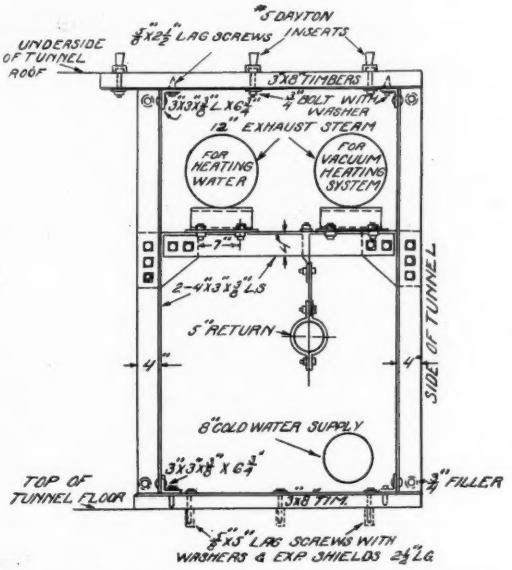


FIG. 6. TUNNEL DETAILS SHOWING METHOD OF SUPPORTING STEAM AND WATER LINES

distribution lines, 2 12-in. exhaust steam lines, an 8-in. cold water supply line and a 5-in. condensate return. Details of this tunnel at various points are shown in Fig. 6. The framework for the support of the pipes is made up of angle irons each side of 2 4 by 3 by 3/8-in. ells and the tops and bottom of 3 by 8-in. wooden members, the former held to the under side of the tunnel roof by means of 3/4-in. bolts fitted with Dayton inserts, while the bottom pieces are secured to the tunnel floor by 5/8 by 5-in. lag screws screwed into 2 1/2-in. long expansion shields. Joining the two uprights and somewhat higher than the center line of the tunnel is a shelf made up of two 4 by 3 by 3/8-in. ells with a 12 by 3/8 by 12-in. plate bolted on top and upon which is placed a 3-in. pipe serving as a roller bearing for the 12-in. exhaust lines. The methods of supporting the 5-in. return and the 8-in. cold water supply lines are shown in Fig. 6.

Anchors for the 12-in. exhaust lines consist of angle-iron brackets carrying cast-iron supports of the form illustrated in Fig. 7, and holding-down straps made up of 3/8 by 1 1/4-in. bars forged to 3/4-in. at the ends and threaded.

The entire electrical and mechanical equipment of this plant as also that in the rest of the works was installed under the supervision of Brenton Boggs, works engineer. T. G. Foster, formerly connected with the Public Service Co. of Northern Illinois, is chief operating engineer.

A FIRM IN BRAZIL wishes to buy compressed air pumps, electrical equipment, dynamos, etc., to enlarge a city water supply. Quotations should be f.o.b. New York, and cash will be paid in advance. Specifications in Portuguese and blueprints may be examined at the Bureau of Foreign and Domestic Commerce, Washington, D. C., or any of its district offices in the larger cities. Also the name and address of the firm may be had. Correspondence should be in Portuguese, if possible, otherwise in Spanish.

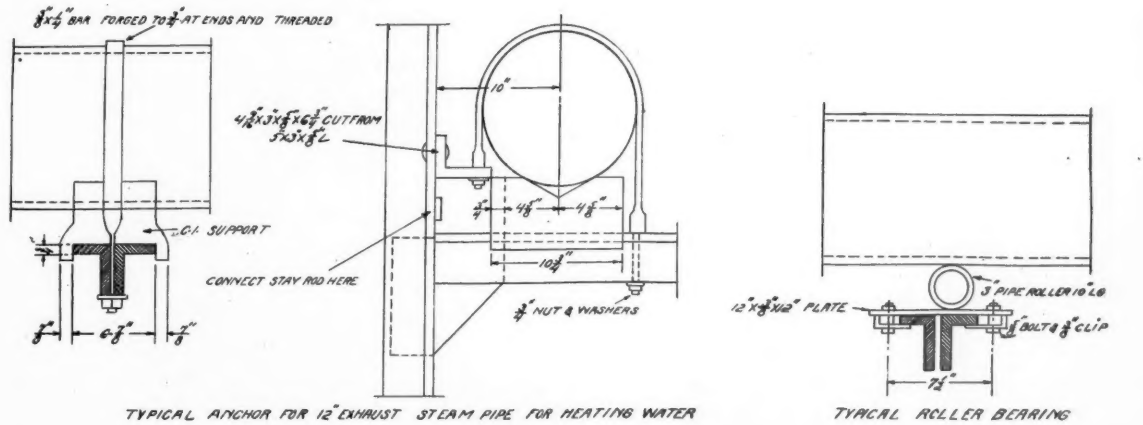


FIG. 7. EXHAUST LINE DETAILS

STEAM AND ELECTRIC DISTRIBUTION

BY MEANS of the connections shown in Fig. 5, steam exhausted by the turbine and the boiler feed pumps passes into an 18-in. header from where the feed-water heater, a 12-in. line for process work and a 12-in. line for heating are supplied; any surplus which may exist is discharged to the atmosphere through an 18-in. riser provided with an 18-in. Cochrane combination back-pressure and exhaust relief valve and fitted with a Swartwout cast-iron exhaust head of like size.

Of particular interest in this installation is the 600-ft. concrete tunnel in which are carried the electric

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A DEALER IN FRANCE desires an agency for the sale of machine tools and electrical supplies in large quantities, quotations to be f.o.b. New York. Further information can be had from the Bureau of Foreign and Domestic Commerce, Washington, D. C.

Exhaust Heads

DESCRIPTION OF VARIOUS APPLIANCES ADAPTED FOR THE SEPARATION OF OIL AND WATER FROM EXHAUST STEAM

UNLESS water and oil are removed from the exhaust steam before it is discharged to the atmosphere, decay of the roofing and pollution of the surrounding air will occur. To eliminate these objectionable features, an exhaust head is installed at the atmosphere end of the exhaust line, and this serves also as a muffler to reduce the noise of the escaping steam.

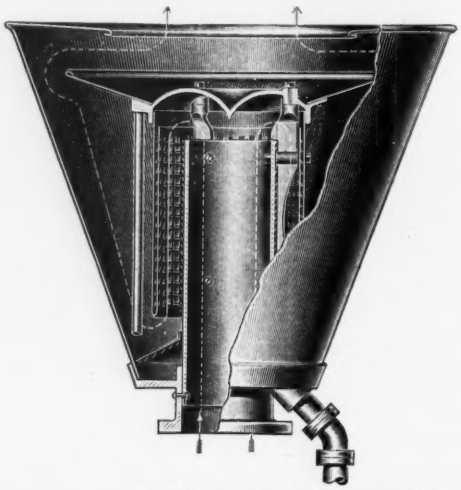


FIG. 1. SWEET'S DIRECT EXHAUST HEAD

Most exhaust heads are designed similar in principle to a separator. Water and oil striking the deflecting surfaces are caught by them, flow downward, and are conducted away through a drip pipe extending downward along the outside of the exhaust line. Steam is discharged, in most types, over the base of an inverted

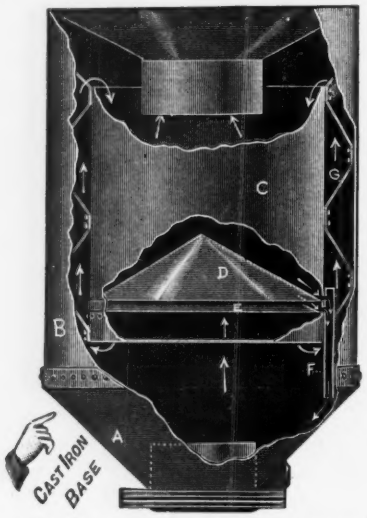


FIG. 3. THE SIMS EXHAUST HEAD

cone with a velocity so reduced that its escape is noiseless. Similar reduction of velocity is also secured by baffling the discharge by means of perforated diaphragms or wire netting.

TYPES OF EXHAUST HEADS

WITH Sweet's Direct exhaust head, Fig. 1, the oil and water are trapped by a perforated lining which throws it to the bottom by quickly reversing the direction of the current of steam. The steam then flows upward along the sides and after striking the rim which forms the top, is permitted to exhaust to the atmosphere. Water accumulated on top is carried from the cone through conductor pipes to the water chamber. Provision is made for cleaning out the water chamber when necessary. A steel tube forms the center pipe; the base is cast iron, and the balance is galvanized iron.

Exhaust steam entering the Wright Cyclone exhaust head strikes an inverted cone. It is then deflected out-

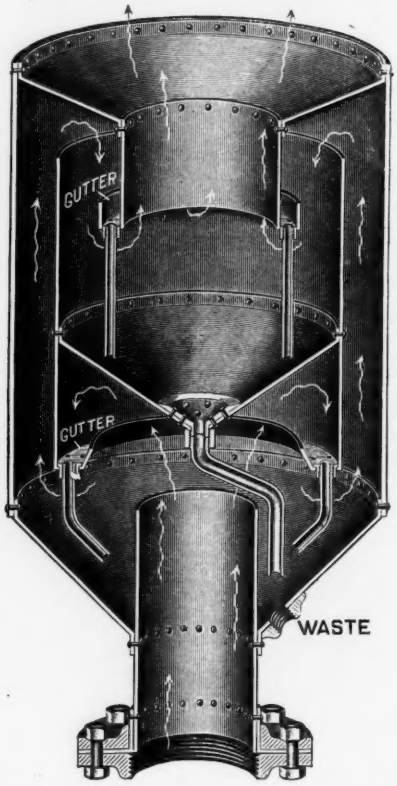


FIG. 2. WRIGHT CYCLONE EXHAUST HEAD

ward against the sides of the inner shell, where the oil and condensation adhere and drip into a gutter, to be carried below the flow of steam by means of 5 copper drip pipes. After being deflected by the cone, the steam passes upward between the outer and inner shells, as shown in Fig. 2, and is again impinged against another inverted cone which forms the top of the head. The steam then turns and passes down between the inner shell and the outlet pipe, the remaining condensation being removed from the steam by its contact with the under side of the top cone and the outlet pipe. Heavy galvanized steel plate is used in constructing this head.

After striking the cone located directly over the inlet of a Sims exhaust head, steam flows upward along

the sides and is then deflected downward into a cylindrical compartment as shown in Fig. 3. Water adhering to any of the conical surfaces flows through the drip pipe, F, to the gutter in the base. This head is made of heavy galvanized sheet iron with galvanized iron braces, and fitted with a cast-iron base.

Embodied in the design of the Swartwout cast-iron exhaust head is the helico-centrifugal principle. As the whirling steam emerges from the helix tube, A, Fig. 4,

FIG. 4. SWARTWOUT EXHAUST HEAD

into the expanding portion of the head, the water particles, which have already been thrown to the outer surface of the tube, are flung outward. Water then collects in the annular chamber, formed by the extension of the tube at B, and is removed through the drip pipe, C. It is claimed that the long pitch of the helix, A, avoids interference with a direct-flow action.

A non-corroding cast-iron construction is employed

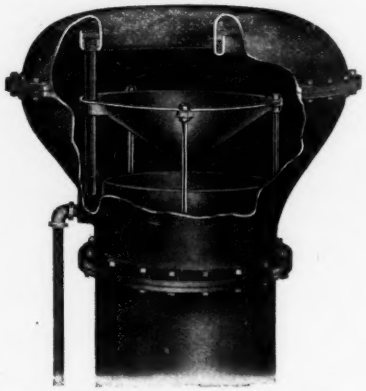


FIG. 5. HOPPES EXHAUST HEAD

in the design of the Hoppes exhaust head. On entering the head, steam expands gradually into a large chamber several times the area of the exhaust pipe. Particles of oil and water in the center of the current are separated by impinging on the cone, shown in Fig. 5, while those on the outer edges strike against and adhere to the side of the separating chamber. Any creep of the entrainment is checked by the trough partly filled with water surrounding the outlet, and all the separated oil and water are carried by drip pipes to the gutter formed in the base by an extension of the pipe.

An appliance which is claimed to combine the advantages of an exhaust head and an open feed-water heater is illustrated in Fig. 6. Exhaust steam entering the Ross heater is conducted to the outer steam space of the heater, in which chamber all oil and grease are extracted, due to the centrifugal action of the whirling steam. The purified steam then passes into the condensing chamber where it comes in contact with the finely divided cold water spray around the base of the exhaust outlet pipe. As in the case of the jet condenser, the steam and the water become thoroughly mixed, and the heated water flows through the bottom outlet into the supply tank.

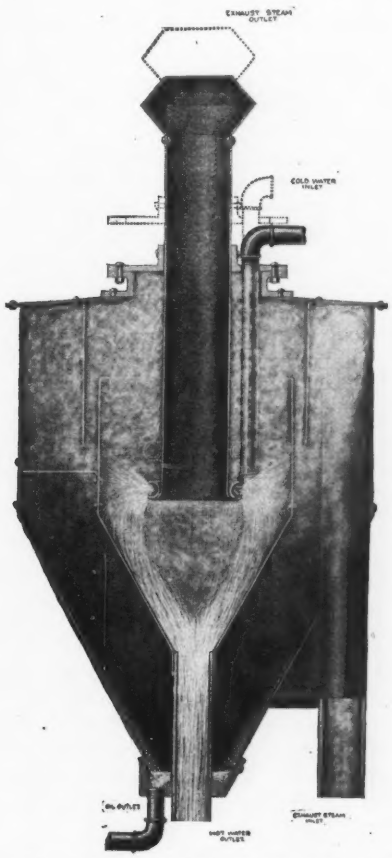


FIG. 6. THE ROSS EXHAUST HEAD HEATER

Where steam comes to an exhaust head from a turbine, the water of condensation may be returned directly to the feed water tank; but if from a reciprocating engine, the oil must be separated by means of an oil extractor or water filter before the water can be returned to the boiler. With an efficient oil separator in the exhaust line, the condensation may be returned to the feed water tank without any further purification. Ordinarily the condensation is carried down and emptied into the sewer. Most city ordinances require the drips to be cooled to 100 deg. F. before discharged into the sewer. In this case, they must first be discharged into a tank, vented to the atmosphere to prevent back pressure, and permitted to cool.

Relation of Efficiency to Capacity in the Boiler Room*

CHARTS DRAWN AS RESULTS OF TESTS GIVE DEFINITE AID TO FIREMEN. BY VICTOR B. PHILLIPS

THERE are two ways in which the cost of producing steam may be reduced. They are efficient operation and the attainment of high capacity from equipment. The table gives the typical figures for the various elements of cost entering into the production of steam, according to the accounts of the Cleveland Railway Company for the year 1914. The numbers shown in parentheses refer to the accounting system prescribed by the Interstate Commerce Commission. This table shows the predominating importance of fuel and fixed charges, and hence the importance of both efficiency and capacity and their interrelation.

To the end of establishing the operating conditions giving maximum efficiency for a wide range of capacities, the writer has made an extensive series of tests for the Cleveland Railway Company. The tests were conducted under widely different operating conditions in order to bring out clearly the importance of the several variables and also to throw light on questions of design.

The performance of the entire boiler unit may be expressed in terms of a number of factors over which the fireman either does or should be able to exercise proper control.

COST FACTORS IN STEAM PRODUCTION

		Per cent of total cost	
1 (53)	Fuel	50.1	50.1
2 (54)	Water	3.4	.....
3 (55 & 56)	Oil and miscellaneous supplies	0.4	.....
4 (46 & 47-A & B)	Maintenance	6.4	.....
5 (52-A)	Employees	9.6	9.6
6 (50)	Depreciation, 4½ per cent on investment	11.3	11.3
To these must be added interest, taxes and insurance, 7½ per cent on investment		18.8	18.8
	Total cost of producing steam	100.0	
	Fuel and fixed charges	.....	89.8

Before proceeding with the separate discussions of the two elements of the boiler unit, it is necessary to define clearly the lines of separation of the furnace and the boiler. It is desirable so to define furnace efficiency and boiler efficiency that their product will be the overall efficiency of the unit. To this end boiler efficiency is taken as the ratio of heat absorbed to the heat available for absorption, i.e.,

$$E_B = \frac{\text{heat in steam}}{\text{heat in steam and sensible heat in flue gas}}$$

Furnace efficiency is defined as the ratio of heat available for absorption by the boiler to the heat in the coal, i.e.,

$$E_F = \frac{\text{heat in steam and sensible heat in flue gas}}{\text{heat in coal}}$$

and

$$E \text{ (overall efficiency)} = E_F \times E_B$$

This method arbitrarily charges against the furnace all losses through the setting, such as radiation and leakage. Most of these losses do occur in the setting around the furnace and so this arbitrary classification is reasonable. It also charges against the furnace the loss in the latent heat in the vapor of the discharged flue gases.

THE FURNACE

THE IDEAL furnace for any form of fuel is one in which the three factors of combustion—amount and admixture of air and time for completion of combustion—may be regulated independently. This furnace would have wide limits of efficient operation wherein it would be possible to attain at once both efficiency and capacity. Unfortunately the present status of the art, particularly in regard to coal-burning furnaces, falls far below this ideal.

The most important methods of firing coal employ the chain grate and the underfeed and overfeed gravity stokers. In each of these cases the time of transit of coal decreases with increase of load and is not subject to independent regulation, and also it is impossible to regulate independently the amount and admixture of air. The factors of air supply are controlled together by the amount of draft or pressure and by the condition of the fued bed. These several inflexibilities are inherent in the present status of the art. They are serious disadvantages which may be reduced, however, by introducing in other ways a large degree of flexibility.

Since regulation of the time element by regulation of grate surface seems to be impracticable, the problem of furnace operation becomes simply the problem of the air supply, not merely over the fuel bed as a whole, but in its several parts separately. The flexibility of air supply will to some extent compensate for inflexibility in time of transit, may be illustrated by any of the underfeed gravity stokers. The grate areas of these stokers have been proportioned to give the proper time element for rated capacity.

FUNDAMENTAL FACTORS OF OPERATION OF THE FURNACE

THE OPERATING variables of the furnace are simply the variables governing air supply. They are (1) thickness of fuel bed, (2) condition of fuel, and (3) pressure drop through fuel bed. These variables may be regulated differently in different parts of the furnace, but they are in all events the fundamental factors involved. They determine efficiency and capacity. In order to operate a furnace properly, the inter-relations between efficiency and capacity and the foregoing variables must be established.

The validity of this principle has not been generally realized. Instruments for the indication of certain variables have been extensively used. Yet, either the number of instruments or the amount of rational interpretation has been insufficient. It is only in very special and limited cases that efficiency or capacity is indicated by a single variable factor such as carbon dioxide, or flue temperature.

Having defined the fundamental factors of operation, it now remains to select means of indicating these qualities to the fireman. The means of indication necessarily vary for different types of stokers and furnaces.

*From a paper presented at the spring meeting of The American Society of Mechanical Engineers.

With a chain grate the thickness of fuel bed may be readily measured and adjusted, and its condition is for the most part uniform. The draft in the combustion chamber constitutes the pressure drop through the fuel bed. Thus the chain grate readily lends itself to this system, and it is a simple matter to determine by tests the relation of furnace efficiency and capacity to the operating variables. In fact, the limits of expedient and efficient operation with the chain grate are not only narrow, but readily apparent. This is a salient feature of this type of stoker. On the other hand, the forced-draft underfeed stoker is not by any means so simple, and here intelligent control is not only effective but essential. In this case the thickness of fuel bed cannot be directly measured nor is its uniformity so much a matter of course.

The point of primary importance is the amount of air pushed through the fuel bed and the intimacy with which it is mixed with the volatile matter forming in the lower layers of green coal and the coke of the upper layers. Roughly speaking, this intimacy increases with the resistance to air flow. It is the condition and thickness of the fuel bed that determines both the amount and admixture of air. The pressure necessary to force up a certain quantity of air is both a simple and an effective indication of the mean condition and thickness of the fuel bed; in other words, an air-pressure gage and an air meter indicate the thickness of bed. In stokers of sufficient size to warrant the use of two air ducts, it is necessary to duplicate the air-measuring apparatus. By proper arrangement of the means of indication it now becomes possible to gage the uniformity of the fuel bed by comparing the air indications to the two halves. Thus all the conditions governing air supply may be readily measured, and indicated to the fireman. In order that he may make proper use of these indications they must be related to the objects sought—efficiency and capacity.

As an illustration of the actual interrelating of the above indications, there is presented in Fig. 1 a chart showing graphically the results of the tests applying to the furnace.

It may be seen that this chart is a graphical representation of the principles outlined above. It shows how furnace capacity and efficiency are functions of extremely simple variables, and how any two of the variables fix conditions of operation. An analogy is a steam chart on which any two conditions, such as heat and pressure, or quality and temperature, determine a point from which the other corresponding conditions may be found. The chart brings out in conclusive manner the essential importance of the variables selected at the beginning of the discussion—thickness of fuel bed and pressure drop. So far as the furnace as a heat liberator is concerned, it establishes the conditions of maximum efficiency for each and every load.

Measurement of Air Supply

Of the instruments used by the writer in obtaining the results presented here, the apparatus for directly measuring the air supply merits perhaps a brief statement. It is quite possible to employ the pitot tube with close accuracy for measuring the air supply of forced-draft furnaces, and even where conditions are extremely unfavorable to obtain at least excellent relative results. The manometer used in connection with the pitot tube may be placed at a distance from the air duct, along with the other boiler instruments, without impairing its accuracy. When two manometers are necessary because of two air ducts the sloping tubes may be placed side by side and readings taken from a single scale. The only time that the liquid levels will not be side by side will be when the fuel bed is not uniform, a condition requiring immediate attention from the fireman. For example, a hole will cause a very marked difference in the two manometer levels.

Another principle may be employed in connection with the form of air meter just described. The pitot-tube manometers show deflections increasing as the square of the air velocities. Similarly, neglecting the relatively small amount of gas formed from the burning coal, the pressure drop through the fuel bed varies as the square of the air velocities. Hence the relation between this pressure drop and the manometer deflection is a direct proportion. Utilizing this principle,

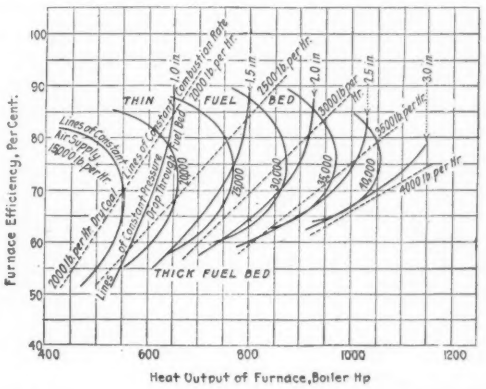


FIG. 1. FURNACE OPERATION CHART. TAYLOR 6-RETORT STOKER WITH EXTENSION GRATE

another manometer tube may be placed beside the other tubes for the measurement of pressure drop. By using liquids of the proper relative densities, or by introducing variation in the sectional area of the manometer, the levels can be set to move up and down together for the proper thickness of fuel bed; and a ready indication of amount of variation from the prescribed thickness is available. This last function is valuable in plants having short peak loads. The fireman may gage the amount by which he is building up his fuel preparatory to the short overload. Thus a single instrument has been made to indicate all the fundamental conditions of combustion—amount of air, pressure drop through the fuel bed, and thickness and uniformity of fuel bed.

The Boiler

Performance of the boiler as an apparatus for absorbing heat is here analyzed in the complete paper along the same general lines as the furnace. The furnace produces heat which is available for absorption in the form of radiant energy and of hot gases, that is, the heat generated in the incandescent fuel bed is transmitted to the boiler surfaces by radiation and by con-

vection. It is then transmitted from the outer to the inner surfaces and to the water by conduction. The boiler employs, therefore, all three modes of heat transmission, and the variables of operation are those determining the effectiveness of each of these three modes. These variables are (1) temperature, (2) condition of surfaces and (3) gas velocity. Temperature is the predominant variable; it affects all three modes of transfer, in each case a temperature gradient being necessary. The condition of surfaces affects principally two modes of transmission, convection and conduction; while gas velocity affects simply convection.

Boiler-Operation Chart

Relations derived between the heat absorbed by the boiler, and the two variables—flue temperature and gas velocity—are combined into a single chart, Fig. 2,

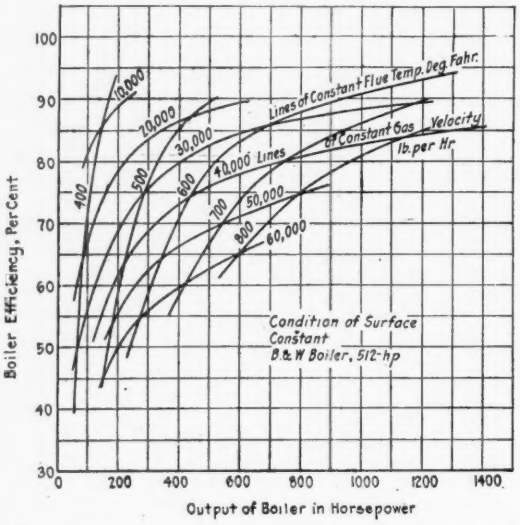


FIG. 2. THE BOILER AS A HEAT ABSORBER. BOILER OPERATION CHART SHOWING INTERRELATION OF VARIABLES

which is the boiler-operation chart, and corresponds to the furnace-operation chart previously shown. It expresses the relation of efficiency and capacity to the fundamental factors—temperature and velocity of the gases.

Combined Boiler-Unit-Operation Chart

Following this separate treatment of the two elements of the boiler unit—the furnace as a heat liberator and the boiler as a heat absorber—the paper here combines the results of the two analysis. As an example of such procedure there is presented in Fig. 3 the combined boiler-unit-operation chart.

It is evident that the factors governing furnace operation also determine the variables of boiler operation. The gas passing through the boiler is simply the air of combustion plus the weight of gasified coal (corrected, if necessary, for infiltration). The temperatures in the boiler are governed by the combustion conditions in the furnace. Hence, overall boiler efficiency and capacity are to be expressed simply in terms of the furnace variables—thickness of fuel bed and pressure drop through fuel bed. In the case presented here fuel bed thickness is indicated by weight of air and pressure drop, and these values therefore become the criteria of combined performance. The function of flue temperature is simply a check upon the condition of the heating surfaces. The combustion rate curves shown on the chart are of value only in assisting in the proper maintenance of fuel bed. However, this information is not necessary, since an insufficient fuel supply shortly disturbs the prescribed relation between air and pressure drop. Reference to the data shows very little variation in the character of the coal used in the tests, the results of which have been here presented.

The combined boiler-unit-operation chart brings out the essential importance of the variable factors which have been selected as determining performance. It supplies the information whereby the firemen may operate with maximum efficiency for each different load. It establishes the relation between efficiency and economy wherewith the economic policy of the boiler room may

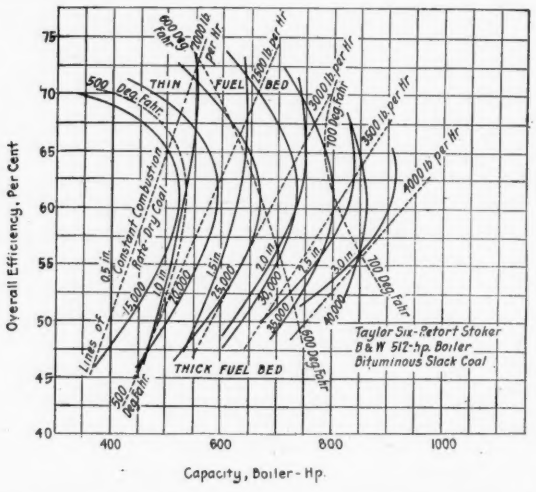


FIG. 3. OPERATION CHART, COMBINED BOILER UNIT

rationally be planned. Lastly, a study of the chart and of the reasons for its characteristics becomes a sound basis for improvement in design.

Breechings, Dampers and Stacks

Proportions Recommended by the Standards Committee, Smoke Prevention Association as Offered by Osborn Monnett of American Radiator Co.

BREECHINGS should be as short as possible, preferably with straight direct run to the stack without turns. Where turns are unavoidable, use long bends with radius on center of turn at least equal to diameter or width of breeching. Slope gradually upward with no dip below the horizontal. Connection to the stack should slope upward at 45 deg.

Breechings should be of non-porous material, and if of steel plate should have reinforcing angle irons on the outside, the inside being smooth. Insulation should be on the outside where it can be readily inspected and repaired without interrupting operation. Clean-out doors should be provided at convenient points.

For water-tube boilers, make ratio of breeching area to grate at least 1 to 4½; for return tubular boilers, at least 1 to 4. Use round or square section if possible;

if rectangular is necessary, the long side to be not more than 1⅓ times the short side.

Dampers

These should occupy the full width of available opening, and be of type and so hung that when wide open no obstruction is offered to movement of the gases. No damper should be placed in the main breeching.

For water-tube boilers, the free opening should be ¼ the grate surface, and for return tubular boilers, 1¼ times the combined area of the tubes.

Stacks

Stacks should be so located as to get the most favorable run of breeching. A steel stack should be lined with fire brick to a height 10 times its diameter.

For water-tube boilers, the free stack area should be at least 1/5 the area of total grate surface served, if less than 150 ft. high; and at least 1/6 that area if over 150 ft. Return tubular boilers should have a stack with area at smallest point at least 1¼ times the combined area of all tubes served.

Height depends on the draft needed to burn the coal and overcome friction in boilers and breechings. The formula for draft of a stack is:

$$D = 0.52 \times H \times P \left(\frac{1}{T} - \frac{1}{T_1} \right)$$

Where D = draft in inches of water
H = height of stack above grate in feet
P = atmospheric pressure, lb. per sq. in.
T = atmospheric temperature absolute
T_1 = stack gas temperature absolute

Assuming T = 60 deg. F. and P as 14.7 at sea level, and that 0.1 of 1 per cent of height of stack be allowed to overcome its own frictional resistance, the formula may be written:

$$D = H \times U$$

Where U is a value depending on stack gas temperature, and has values as follows:

Stack Gas Temp. Deg. F.	Value of U	Stack Gas Temp. Deg. F.	Value of U
750	0.0074	500	0.0057
700	0.0071	450	0.0053
650	0.0068	400	0.0048
600	0.0065	350	0.0043
550	0.0061	300	0.0036

If it is desired to find the height needed to produce a given draft, the formula becomes: $H = D \div U$.

To inform the people of the nation as to the problems now confronting us in the war, the National Security League is acting in co-operation with the Chautauqua Institutes throughout the country, and July 2 to 7, a Training Camp for Speakers will be held at Chautauqua, N. Y. More than 200 university and college presidents and professors, lawyers, editors and business men from all parts of the country have volunteered to work in this speaking campaign. Every organization is invited to appoint representative delegates to attend the training camp and to participate in the further activity. Information may be had from E. L. Harvey, 31 Pine St., New York.

Helping to Win

National resources must be utilized to the utmost in order to provide fuel, steel, arms, munitions, equipment, ships and men so that the struggle to preserve the liberty of nations and their right to choose how and by whom they shall be ruled may be successful.

Among the great needs are fuel and transportation, and the railroads of the country are using their best efforts to meet these needs. For the period of the war the railroads have agreed to operate as a great unified continental system under the guidance of a committee of 27 executives directed by an executive committee of five which is cooperating with the Council of National Defense and with the Army and Navy Departments, to give preference to moving essentials as rapidly as possible, and to get the maximum service out of cars.

In this latter effort, cooperation of shippers is needed to insure that cars are loaded as nearly as possible to maximum capacity, and that they are loaded, sent out and unloaded promptly, so that each car shall carry its full load and be kept moving. Cars should not be held idle waiting for loading, nor held after delivery and used for storage.

Duplication of passenger service is to be avoided, also, not to the inconvenience of travelers, but to do away with unnecessary trains that have been run largely as a matter of competition. Nonessentials are to be eliminated, and essentials given right of way.

This is required in order that the railroads may have maximum effectiveness in doing what is needed, and shippers and travelers must be prepared and should be eager to give up some preferences and luxuries in order that the needs of the country may be met.

Centrifugal Pumps for Boiler Feed

Capacities and Power Required and Limit of Economical Employment

In an article by M. W. Ehrlich in the Iron Age, the following data are given:

Practice has shown that the steam turbine drive is the most reliable for centrifugals used for feeding boilers, but motor-driven pumps are often advisable for relays or duplicate units.

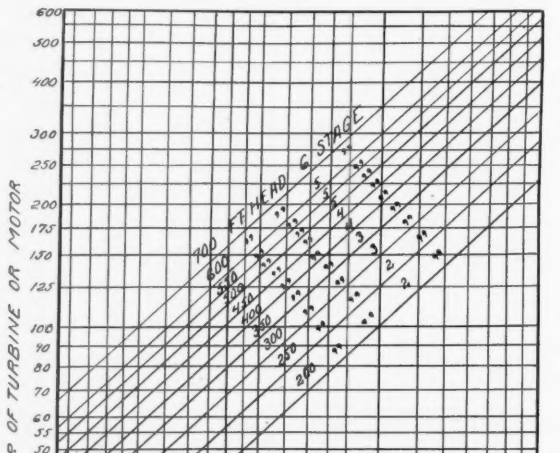
The minimum size for economy seems to be considered as 250 gal. per min. which corresponds to about 3000 boiler horsepower at 125 lb. pressure. Such a pump of good design, working against 300 ft. head requires a 40-hp. motor or turbine, the pump being 3-stage type with 3-in. inlet and outlet.

For heads not over 150 ft., corresponding to 65 lb. pressure, single stage pumps of turbine or volute type may be used. For greater heads or pressures, two or more pumps in series, (2-stage) should be provided, each stage being good for 100 to 130 ft. head, with efficiency range from 50 to 70 per cent, depending on the capacity of the pump. Small capacity pumps have low efficiency, particularly if the pump is run to deliver less than 75 per cent of its rating. The capacity increases as the head is reduced, speed being constant. The pump must be carefully chosen, therefore, for its normal working conditions, as in order to get good effi-

ciency the impeller must be of a design and proportions to meet those conditions.

Boiler feed pumps should be of a capacity such that gallons per minute = boiler horsepower × 0.06. Total head, made up of suction lift, discharge head, boiler pressure, pipe friction and velocity head—must be carefully determined and specified.

For temperatures above 115 deg. F. (46 deg. C.) water should come to the pump by gravity, and the suction head to the center of the pump would be deducted from the discharge head to determine the normal head. Discharge head is the distance from the center of the pump to the point of discharge to the boiler, and boiler pressure × 2.3 gives the head equivalent to that pressure. Pipe friction must be determined from tables or curves such as shown on p. 34 of the Jan. 1 issue of Practical Engineer, and if water is forced through a feed-water heater, allowance for that friction must be made on data secured from the heater manufacturers. Velocity head = the square of the velocity in feet per second at the pump nozzle divided by 64.4; in practice it ranges between 1.5 and 2.5 ft.



CAPACITY AND POWER CHART FOR CENTRIFUGAL PUMPS

Having normal head and capacity of the pump, the power of motor or turbine to drive it is found from the chart herewith, which takes into account the efficiency for different sizes. Each pump is supposed to have the number of stages best for the head to be overcome as indicated on the chart.

Rating of capacity is usually given by makers in U. S. gallons per minute at a velocity of 10 to 12 ft. per second in the outlet nozzle. This gives a basis for rating on size of nozzle, and the relation is shown at the bottom of the chart.

As an example, for 1000 gal. per min. against 350 ft. head, a 6-in. pump is the nearest size. Above on the 350 ft. head diagonal is found 3 stages, and the left hand scale shows 145 hp. required for 1000 gal. at 350 ft. head. The nearest commercial size of turbine or motor would be 150 hp.

Rules Affecting Boiler Plate Amended

ON account of the contention of manufacturers of boiler plate that the requirements of the rules of the Board of Supervising Inspectors, United States Steamboat-Inspection Service, governing the manufacture of steel boiler plate are stringent, resulting in a cost of from 5 to 6c. a pound for steel boiler plate manufactured under the rules of the Steamboat-Inspection Service over steel boiler plate subject to the rules of Lloyds Bureau, the executive committee of the Board of Supervising Inspectors, at a meeting held from May 16 to 19, inclusive, 1917, adopted the following rule for physical qualities of steel plates:

"The tensile strength determined by the tests shall be not less than 58,000 lb. per sq. in. of section, nor more than 73,000 lb. per sq. in. of section, and the elongation measured in a gage length of 8 in. shall be not less than 20 per cent."

The rules reading "All holes for tubes shall be drilled and no part punched" and "All holes for stays shall be drilled and no part punched" were struck out, and the following new rule was adopted:

"Centers or guide holes not to exceed 75 per cent of the diameter of the full size finished hole for tubes and stays may be punched. The remainder shall be cleanly cut, drilled or reamed to full size."

These amendments received the approval of the Secretary of Commerce on May 19, 1917, under the provisions of section 4405, Revised Statutes.

The Steamboat-Inspection Service has issued a circular letter dated May 22, 1917, which contains these amendments in full. The circular letter will be issued to manufacturers of boiler plate, boiler manufacturers, and to all persons on mailing lists to receive the general rules and regulations of the board of supervising inspectors. Copies of the circular letter may be obtained on application to any board of local inspectors, Steamboat-Inspection Service.—Commerce Reports.

PERHAPS THE best chemical test for carbon monoxide, in that other gases do not interfere and very simple apparatus is required, is by the use of blood diluted with water to a buff-yellow tint. This test, in the author's experience, is capable of distinctly showing as little as 0.03 per cent of carbon monoxide in the atmosphere. The method of procedure is as follows:

One or two drops of blood from the finger are diluted with water until equal portions of the solutions placed in 100 c.c. test tubes have a buff-yellow color; one of the tubes is taken into the mine, and at the place where the air is to be tested about 50 c.c. of the blood solution is poured out, the mine air taking its place. The tube is then corked, taken to the surface, and gently shaken for 10 min. If the air contains carbon monoxide, the pink color caused by the presence of carbon monoxide hemoglobin is detected by comparing the solution with the normal blood solution in the other tube.—U. S. BUREAU OF MINES TECH. PAPER 11.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Dynamo Brushes

A Study of Their Manufacture, Characteristics and Application

PRACTICALLY all early generators and motors were at first equipped with copper gauze or copper leaf brushes, and it was not until the introduction of the reversible motor that the need of a brush of more solid and substantial structure was felt. A block of copper bearing directly on the commutator was tried, but proved a failure on account of the arcing and spattering of the metal due to the excessive flow of armature-coil short-circuit current passing through this block of low-resistance material. This was, in fact, also one of the reasons for the adaptation of the laminated-copper brush which, despite the high degree of perfection the present-day carbon brush has attained, is still employed in some classes of service.

A typical brush of the laminated-copper type is the Wirt Dynamo Brush manufactured by The Cutler-Hammer Co. This brush, which its manufacturers claim will operate satisfactorily even when the surface of the commutator presents inequalities tending to cause excessive sparking, is, in addition to the copper laminations, provided with leaves of anti-friction and high-specific-resistance metals. Mechanical structure is such as to provide sufficient elasticity to insure good contact with but slight pressure, thus eliminating unnecessary friction and its accompanying rise in temperature and increased wear on both brush and commutator. Stiffening strips on the outside serve to keep the brush in shape and to make proper contact in the brush holder.

The first carbon brushes are said to have been made from stock such as used for arc-lamp and dry-cell carbons. This was mixed, molded and baked in much the same manner, and the price fixed on that basis.

Radical changes in the processes of manufacture within the last few years have brought about improvements in brush performances tending to eliminate many of the troubles formerly experienced. As a rule, however, brush manufacturers refrain from making public their work, evidently preferring to keep the processes as trade secrets.

Much information along this line is, however, available in a paper entitled Brushes, by W. R. Whitney, which appeared in the 1912 Journal of the Franklin Institute. Referring to the compositions of the mixtures employed, Mr. Whitney states that while these are varied to suit requirements, they are general, made up of 2 or more of the 4 elements: lampblack, finely ground petroleum coke, graphite and some kind of tar or petroleum pitch to serve as a binder. The petroleum coke is used because of its uniformity and freedom from mineral matter.

Each of these ingredients produces a different effect, and a suitable proportion seems necessary and varies with the use of the brush. A brush made mostly of lampblack, with a suitable binder, would be dense and hard, but of poor conductivity and would cut copper badly. One made mostly of graphite is usually too soft and on ungrooved commutators wears away too rapidly. It can readily be appreciated that for some special purposes, it may be well to incorporate hard polishing material into a brush as where much mica must be cut and where high conductivity, and therefore much graphite, is desired.

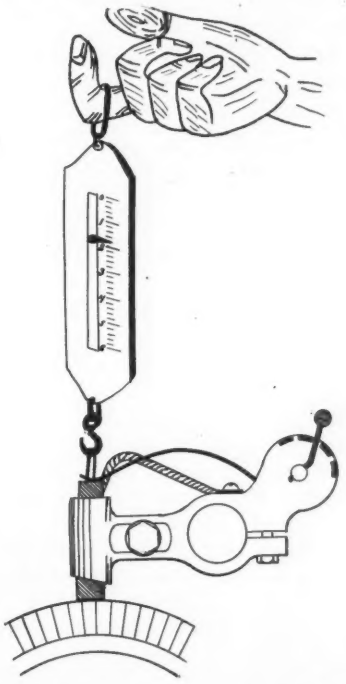


FIG. 1. A SMALL SPRING SCALE ARRANGED IN THIS MANNER WILL READILY INDICATE THE BRUSH PRESSURE

One method of manufacture consists of kneading for several hours in a mechanical dough mixer, a finely-divided mixture of coke, lampblack and graphite to which has been added a solution of the pitch in benzol. The benzol is then driven off by heat and the dried

product which is then quite hard, is reground to 200 mesh and compressed into brush form in steel molds.

Brushes have been formed by squirting bars of the mixture of the ingredients through suitable dies by means of a hydraulic press, but from reports of such processes, it is learned that the tendency of the material to flow unequally within itself during its passage through the die appeared responsible for cleavage planes and internal curved surfaces which would often develop only after the brush was completely baked and even then could be disclosed only by breaking the brush.

After being pressed, lots of 100 to 200 brushes are packed in cast-iron boxes covered by a liberal layer of fine coke and in turn by a well-fitting cast-iron cover carrying a layer of coke dust. This box is then placed in an electrically-heated oven where the brushes are slowly baked at a high temperature.

Referring to the subject of brush manufacture, E. H. Martindale states that for the higher carrying capacities, brushes have been made up of layers of copper gauze and carbon, the former to give proper carrying capacity and the carbon to give the high contact resistance necessary to cut down short-circuit currents. In recent years, the demand for high carrying capacity

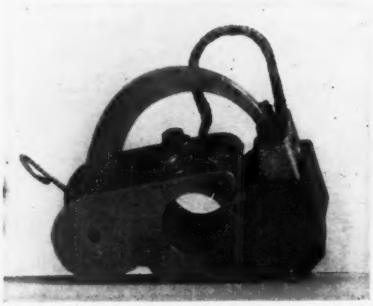


FIG. 2. BOX TYPE BRUSH HOLDER

brushes for slip rings of rotary converters as well as for automobile starting motors has resulted in a development of brushes composed of a mixture of graphite and copper or some other metal, the layers of copper gauze and carbon and the mixtures of metal and graphite being pressed or molded into blocks from which the finished brush is later cut. Some of the carbon and graphite combinations are molded or pressed into blocks, while other combinations are squirted or extruded in long strips and baked to reduce the binder to carbon.

Abrasiveness of Brushes

Unequal wear of copper and mica commutator segments requires at least some abrasive to keep the mica flush with the copper and to retain a polished commutator. This is secured by means of impurities such as mica, silica, iron oxide, carborundum and quartz which are generally present, the last two being the most abrasive. With like amount of impurities, soft brushes, due to their tendency to wear more readily, are found the more abrasive.

Brush Selection

In the selection of brushes for commutators and slip rings, several important factors must be considered. Among these are, according to C. H. Smith in his paper entitled Brushes for Commutators and Slip Rings, appearing in The Electric Journal, the following:

(1) The brush should possess such characteristics as will enable it to carry the maximum current to be transmitted by it. This maximum current consists of 2 factors, for either direct current or alternating current use, viz.: (a) The kilowatt load or working current of the machine, whether direct or alternating and (b) in direct-current service, the short-circuiting current between the bars being commutated, and in alternating-current service, the magnetizing currents due to power factors above or below unity.

The kilowatt load or working current is readily measured or determined in terms of either direct current or alternating current, and for alternating-current service, the magnetizing, wattless or idle currents can also be definitely measured or calculated. The short-circuiting current under the brush is, however, a very indefinite factor and may have values ranging from approximately zero in a machine possessing ideal commutating characteristics to values in excess of the load or metered current in machines having poor commutating characteristics. Brushes, therefore, may be and generally are subject to loads greatly in excess of the load or kilowatt current.

Copper leaf brushes can carry 150 amp. per square inch with a drop of 0.3 v. at the contact. Carbon brushes can carry 35 w. per square inch as for example 35 amp. per square inch with a drop of 1 v. at the contact.

For sparkless commutation (a) the current density in the brush tip must not become infinite, and (b) the average amount of energy expended at the brush contact must be limited. For machines required to operate without sparking up to 25 per cent overload, a rate of energy dissipation of 35 w. per square inch may be allowed at full load, the permissible current density depending upon the voltage drop across the brush contact. The better the commutation, the more nearly uniform is the current density in the brush contact, and the higher the average density which may be allowed.

2. The brush should be homogeneous, that is, uniform in material, mixture and hardness.

Commenting on this subject, Mr. Whitney states that the fracture, or appearance of the fresh surface produced by breaking the brush across its longer dimensions, discloses very effectively any irregularities produced by improper baking, or pressing. This cross section should be quite homogeneous and the fracture regularly conchoidal or square. No shelves, cracks or angular markings will be disclosed on breaking a well-made brush. It is believed that such internal irregularities represent weakened structure, that even miniature cracks might take up and carry copper from the commutator, and that breaking of a brush in use may often be attributed to internal cracks produced in the manufacture.

3. Brushes for either alternating or direct current should be self lubricating; some operators, however, equip their machines with alternate sets of self-lubricating and non-lubricating brushes depending upon the former to supply whatever lubrication may be required by the others.

4. For under-cut commutators, the brush material should be entirely, or to a great degree, free of abrasive

material or the commutator will wear unduly fast, bridge the slots, necessitate frequent beveling of the bars, repeated undercutting and constant cleaning.

5. For smooth commutators with soft mica, a larger percentage of abrasion is desirable than in brushes for undercut mica.

6. For smooth commutators with soft mica, brushes should be highly abrasive. This usually means a decreased brush capacity and decreased lubricating values, although it is claimed for some brushes that proper abrasive effect is secured by hardening under enormous pressure, no abrasion being used.

7. For alternating current or slip rings, the brushes should be as nearly self-lubricating as possible and should themselves wear rather than wear or cut the rings. These brushes may be of metal graphite composition or of a graphitic nature only. If of metal graphite, they should not wear so as to form a continuous "fringe" or "wire edge" along the sides of the brushes at the rings, but should be of a mixture sufficiently granular to disintegrate or break away in small particles.

Continuing, Mr. Smith informs us that to a limited degree, at least, the characteristics of a brush are indicated by the degree of its hardness. Exceedingly hard brushes generally carry a large amount of abrasive and have a low current density or carrying capacity, while the softer ones possess but a small amount of abrasive, are highly graphitic and have a high current density. For high-speed electrical machines such as turbo-generators and high-speed rotary converters, it is at times of advantage to employ brushes of a low density rather because they tend to maintain a more intimate contact with the commutator than brushes of high density. A dense graphitic brush of high conductivity has by experience been found to be especially suitable for steel and cast-iron slip rings, while soft graphitic brushes of high conductivity are recommended for low-voltage generators and boosters.

Brush Tension

Proper brush tension is of considerable importance in the operation of dynamo electric machinery, especially so when working the brushes at a high current density. If the pressure is not equal on all brushes, the load will not be divided equally among them, and overheating will occur with detrimental results.

Brush tension may range from a minimum of 2 lb. per square inch to a maximum of 5 lb. per square inch, depending upon the characteristics of the brush, the speed of the commutator and the mechanical condition of the commutator. Generally, however, tensions of 2.5 to 3.5 lb. per square inch are used on commutators and 3 to 5 lb. per square inch on slip rings, with the exception of crane, hoist and railway motors, for which tensions of from 4 to 7 lb. are recommended.

Experienced operators can frequently determine the tension or pressure with which the brush bears against the commutator by slightly raising the brush in the brush holder. It is, however, preferable, especially for the inexperienced man, to determine this tension by means of a small spring scale in the manner indicated in Fig. 1. In making these determinations, care should be exercised to see that the brushes work freely in their holders and unless the angle of pull is the same on each brush the results will differ.

A tension in excess of that actually required should not be employed, as doing so increases unnecessarily the coefficient of friction between the brushes and the commutator, which in turn results in energy losses of values not ordinarily realized by the average engineer.

The number of watts loss in any given machine due to brush friction may be readily determined by means of the following formula given by E. H. Martindale in a recent issue of the Electrical Review:

$$W = \frac{A \times P \times F \times S}{44.26}$$

where W is the loss in watts, A is the total area of brush contact in square inches, P is the brush pressure in pounds per square inch, F is the coefficient of friction of the brush, S is the peripheral speed of the commutator expressed in feet per minute and 44.26 is the number of foot pounds equivalent to one watt.

The coefficient of friction of a carbon brush, as defined by Mr. Martindale, is the ratio of the frictional pull of the commutator on the brush to the pressure of the brush on the commutator and varies from a little above zero to over 0.9.

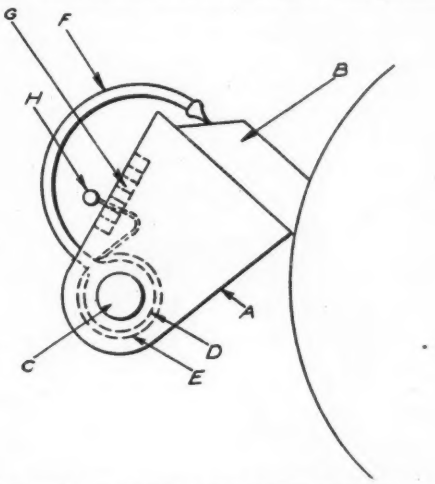


FIG. 3. REACTION TYPE BRUSH HOLDER

Brush Holders

While in detail brush holders employed in connection with present-day electrical machinery may vary to some extent, the box and reaction types such as shown in Figs. 2 and 3, respectively, are now used almost exclusively. In the former, the brush is carried in a slot and a helical spring acts through a finger arm to hold the brush firmly against the commutator in such a manner as to permit movement of the brush parallel to the face of the holder only. This insures the brush readily following any irregularity in the commutator and prevents chattering. Adjustment of the brush pressure is accomplished by means of a series of notches on the body of the holder by which the spring tension may be varied.

Another brush holder, also of the box type but employing a somewhat different form of spring, is illustrated in Fig. 4. The spring is held in place by a guard and is protected from rusting by a heavy coat of enamel.

It is adjusted by means of a ratchet and is so designed that its pressure remains uniform as the brush wears. A brush holder of this same general type for use in connection with collector rings is shown in Fig. 5.

In the reaction type of holder, Fig. 3, brush B is pressed tightly against the holder, A, by the lever, F; this lever is given tension by a coiled spring, E, about a sleeve, D, which moves freely on the brush holder stem, C. G is a series of notches for receiving the spring projection, H, by means of which the spring tension is governed.

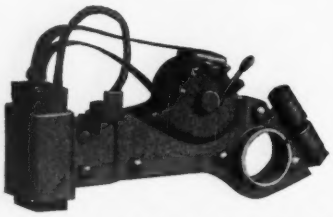


FIG. 4. BOX TYPE BRUSH HOLDER

Proper and sparkless operation of dynamos requires equal spacing of the brush holders. In order to do this, take a piece of paper several inches wide and of the same length as the circumference of the commutator and measure and mark it into the same number of equal spaces as there are brush holders. Then by placing the paper around the commutator under the brushes and shifting the brush arms so that the toe or heel of each set of brushes will come to its respective mark on the paper, the brushes are equally spaced.

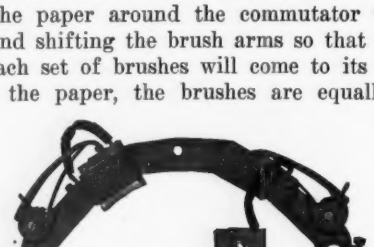


FIG. 5. BOX TYPE BRUSH HOLDER FOR USE IN CONNECTION WITH COLLECTOR RINGS

This may be done in a few minutes time and the paper laid away for future checking up of the adjustments if the diameter of the commutator has not been altered by excessive wear or turning down.

Another way to check up this adjustment is to prick punch the ends of the commutator bars under one edge of each set of brushes after they have been correctly spaced. To check, bring the punch mark to one set of brushes and then see whether all the other brushes coincide with their punch marks on the ends of the commutator bars.

Pecentage Cost Distribution of a Modern Substation

By John D. Morgan

THE modern substation has become a most important link in the development of large electric properties and in most cases, its location demands that it be artistic and in harmony with its surroundings as well as being efficient in its design and operation. The substation with which I am dealing is located in a small town of 10,000 population and furnishes current for railway and commercial uses. It is fed by four 3-wire, 3-phase, 60-cycle high tension (13,200 v.), cables size 2-0 and 4-0 (two of each). It has a present kilowatt capacity of 1600, consisting of two 300-kw. rotary converters with air-cooled transformers and two 500-kw. transformers. The building is one-story with a gallery running around its entire width and breadth, all apparatus and equipment being located on the main floor with the exception of the transfer bus, disconnecting switches and feeder potential regulators, the last-mentioned items being located on the gallery.

This article does not deal with design features, but rather tends only to show the cost weight or percentage distribution of costs of the various items that go to make up a modern substation.

Building Items—	Per cent of Total Building	Per cent of Total Bldg. and Mach'y.
Cut stone and brickwork	29.61	7.53
Concrete work	13.98	3.56
Tile and plaster	0.23	0.06
Doors and frames	0.54	0.14
Windows and frames	8.54	2.18
Ventilators	0.51	0.13
Gutters and leaders	1.39	0.35
Roofing	0.89	0.22
Plumbing	2.58	0.65
Painting	2.52	0.64
Miscellaneous	9.44	2.40
Excavation and Back Fill	6.23	1.59
Concrete foundations	6.82	1.76
Engineering and supervision	16.68	4.24
Total building, per cent	100.00	25.50

Equipment—	Per cent of Total Machinery	Per cent of Total Bldg. and Mach'y.
15-Panel switchboard	17.07	12.70
4 2-switch H. T. oil switch compartments	1.13	0.84
13,200 v. 3-wire main bus	0.65	0.49
13,200 v. 3-wire through bus	0.32	0.24
2,400 v. 4-wire main bus	0.40	0.30
2,400 v. 4-wire transfer bus	0.11	0.08
600 v. railway bus	0.03	0.02
600 v. railway auxiliary bus	0.02	0.01
2 300-kw. rotary converter sets	22.55	16.80
2 rotary starting panels	0.17	0.13
2 500-kw. 13,200-2,400 v. transformers	9.15	6.81
2 24-kv.a. potential regulators	2.22	1.65
1 30-kw. constant current regulator	0.75	0.56
1 60-cell storage battery and cabinet	1.22	0.91
Compressed air system	1.03	0.77
4 al. lightning arresters	3.50	2.61
Misc. lightning arresters	0.35	0.26
Misc. apparatus	0.54	0.41
1-kw. 110-v. motor generator set	0.33	0.25
2 2400 v. ground detectors	0.20	0.15
Tools and supplies	0.25	0.18
Structural iron and steel for electrical apparatus	1.02	0.75
L. T. line rack	1.94	1.45

Pot heads	0.22	0.17
Misc. wood	0.04	0.03
Conduit and duct	2.48	1.99
Insulators	0.27	0.20
Cables, splices, armoring	5.48	3.92
Pole lateral	0.25	0.19
Control wire and conduit	1.21	0.90
Electric installation labor	8.06	6.00
Engineering and supervision	12.50	9.31
Total machinery		74.50 %
Total building		25.50 %
Total substation		100.00 %

Recent Large Undertakings in Mine Hoists

GROWTH in the size of mines and increase in the cost of fuel or in many localities the purchase of hydro-electric power has resulted in recent years in the development of three types of hoists, each of which has a particular field of application.

Compound Condensing Hoists

Practically every modern steam hoist of any size installed abroad is of the condensing type and the tendency among American mining men is to specify condensing operation whenever steam is used. It is sometimes incorrectly assumed that a condensing hoist is not a paying proposition except for a mine of great depth. It is argued that the saving due to the vacuum is obtained only when the hoist is running at normal speed and that, during the period of acceleration the heavy steam consumption overbalances the saving during the remainder of the trip. This might be true if the condenser were not properly designed, so as to condense the large volume of exhaust at the start of the trip. Actually, with a properly designed condenser, the saving of about 50 per cent due to the employment of vacuum is just as great during the period of acceleration as when running, and the proportionate saving, by operating condensing, is greater for shallow depth than for a great depth. Of course, the average steam consumption for the entire trip is greater in the case of a hoist for shallow depth than for great depth just as with a noncondensing engine.

The problems of proper cylinder and condenser proportions, of valve gear design and provisions to insure full starting torque and immediate acceleration, have been successfully worked out by the Nordberg Manufacturing Co. The operating results of these engines are generally familiar to mining engineers. Up to a few years ago all of these units were of the twin tandem design, but recently a departure has been made in the case of some very large installations.

In the case of the Homestake Mining Co., the hoist was built with duplex inclined cylinders, 28 and 52 by 42 in., driving two shafts linked by side rods. The cylinders meet at the apex of the triangle as in Fig. 1. This hoist has recently been put into regular service and is the largest compound hoist in operation. It will be surpassed in size, however, by a new unit now being designed by the Nordberg Manufacturing Co. This will be not only the largest compound condensing hoist yet constructed, but also the largest hoist in the world as regards capacity and depth, surpassing in size the great four-cylinder noncondensing hoists for the Tamarack Mining Co. built 16 yr. ago. It will have two high pressure and two low pressure cylinders 32 and 60 in. in diameter with a common stroke of 66 in., arranged at an angle of 45 deg. with the frames meeting at the apex of the base and driving a common crank pin. See Fig. 2. The drum will be of the cylindro-conical type, 16 ft. small diameter and 30 ft. large diameter. This is 5 ft. greater than the diameter of the Tamarack drums. The hoist is designed to handle ten tons of ore, from an ultimate depth of 10,000 ft., the shaft being inclined at an angle of between 35 and 54 deg.

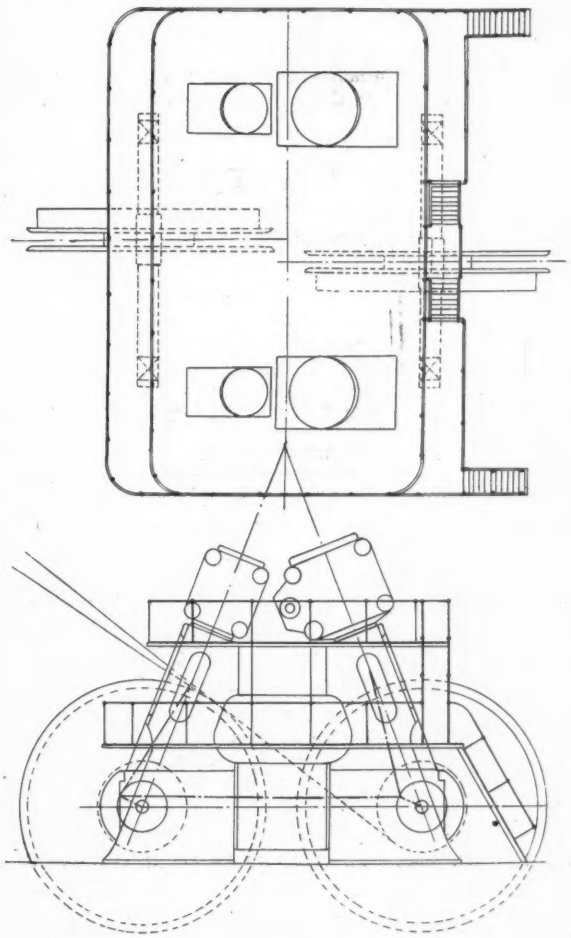


FIG. 1. ARRANGEMENT OF CYLINDERS IN HOIST AT HOMESTAKE MINE

Electric Hoists

Where electric power, usually from hydro-electric generations, is available, two types of hoisting equipment are in use: (1) the motor-driven hoist, and (2) the air-driven hoist.

Rapid strides have been made within a comparatively short time in the use and development of motor-driven hoists, either with induction motor or direct current motor drive and motor generator set. In some cases electric hoists are arranged for full automatic operation, as in the case of the units at the Inspiration Copper Co.,

which were described in a paper read recently before the American Institute of Mining Engineers.

The largest electric hoist under construction for installation in this country is that now being built for the Butte and Superior Copper Co., Butte, Montana. This hoist is designed for an initial rope pull of 41,000 lb. and a rope speed of 2200 ft. per minute when hoisting from a depth of 3000 ft. It has two double clutched drums, 9 ft. in diameter, and is driven by an 1800-hp. motor, direct connected to the drum shaft. When the ultimate depth of 5000 ft. is reached, the drum diameter will be increased to 12 ft. and the hoisting speed to 3000 ft. per minute, and as the rope pull will be increased to 52,000 lb. a duplicate driving motor will be added on the opposite end of the drum shaft.

Air Hoists

One of the drawbacks to the use of the motor-driven hoist is the fact that the motor becomes large and expensive due to the large starting current and the very low speed, particularly in the larger sizes where a first motion hoist only can be considered. With great depth of shaft and load, large rope must be used and large drum diameter, which means slow speed and a large and expensive motor. Furthermore, the transformation of energy from the line through the motor generator set, hoist motor, hoist and shaft, is inefficient. The air hoist, like the steam hoist, is capable of exerting great starting power, and is more efficient than the motor-driven hoist in large installations because the power otherwise wasted in braking is returned to the air storage system, the engine working as a compressor when retarding.

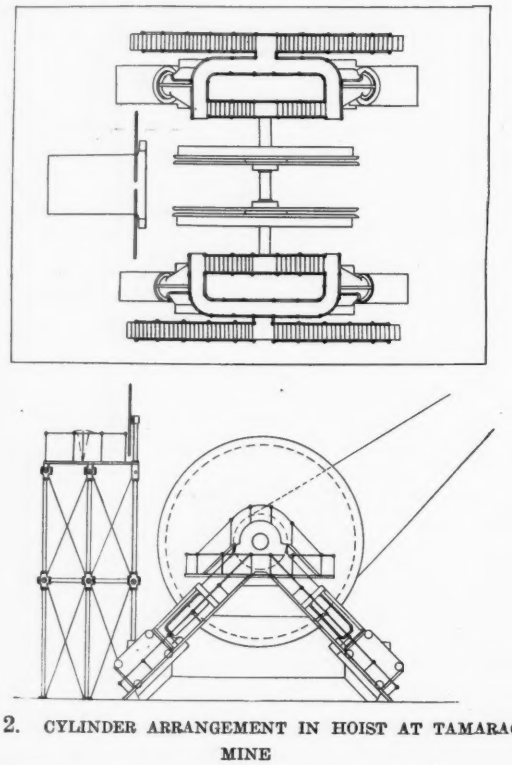


FIG. 2. CYLINDER ARRANGEMENT IN HOIST AT TAMARACK MINE

It should be noted in passing that the growing custom of filling worked-out portion of the mine with rock calls for extensive lowering.

Another feature of considerable weight with many mining men is that in case of an interruption in the electric supply, the air hoists can be operated on the stored air for a considerable period during which the men can be hoisted from the mine.

The majority of air hoists in this country have been installed at the Anaconda mines in Butte, and during the last year four more air hoists have been built by the Nordberg Manufacturing Co. for the same concern. Other air hoists have been built for the North Star mines, and the Mond Nickel Co., and a recent contract calls for an air hoist to go abroad of a size exceeding anything heretofore built either in air, steam or electric hoists.

This hoist will work under conditions requiring the lowering of the load a considerable distance after it has been lifted through the shaft. This calls for an unusually severe braking service, and owing to the great size of the unit a tremendous rate of heat dissipation which would in turn involve many difficult mechanical and thermal problems in the brake design. The braking is solved with comparative ease by the use of air cylinders with the added advantage of returning the air to the storage system. There will be four air cylinders 72 in. diameter with a stroke of 120 in. The general layout will be the same as that of the compound condensing steam hoist described above, Fig. 2; that is, the cylinders will be set at an angle to each other, the main drum bearings being common to both frames at the apex of the base. The drum will be 30 ft. in diameter with 28 ft. cylindrical face, capable of winding 10,000 ft. of 3-in. rope in a single layer. The drum will be one of the largest cylindrical drums, if not the largest, ever built.

Coal supply seems to be one of the probably serious difficulties during the coming winter, and it is interesting to know that the whole matter of coal production is to be taken up by a committee of the Council of National Defense, Francis S. Peabody, of Chicago, being chairman, with offices in the new Interior Department Bldg., Washington, members of the committee being appointed from each important coal producing district, these members to be chairmen of sub-committees for their various sections.

The effort of this committee, cooperating with the mine operators and the mine workers, will be to increase the coal output to the maximum possible, and it is encouraging to note that both operators and men are giving their allegiance to this movement. There will also be cooperation with the railroads, to include transportation, loading of cars, rapid movement and rapid unloading, so as to make maximum use of the transportation facilities. Attention will be given, also, to distributing coal, so that no section will get a surplus, but all sections will get the amount necessary for industrial and domestic purposes. Reliance can be placed on this committee, which is composed of the best informed men in the industry to bring about the most satisfactory possible conditions in the production and supply of coal to all parts of the country.

U. S. Civil Service Commission announces an examination for assistant examiner in the Patent Office, for both men and women, July 11-13; entrance salary, $1500 a year.

Sweated Joints, Litharge and Graphite

By A. G. Solomon

WHETHER a sweated or soldered joint, or one made up with litharge and glycerine, or any other pipe "dope" is the best for pipe joints in refrigerating systems, will depend greatly on where the pipe work is erected and for what purpose it is used.

The continuous welded coil is now being used extensively in ice and brine tanks, and this does away with a great many flanges and couplings which were formerly used. Instead of using return bends which are made so close and unhandy that it is almost impossible to tighten the bolts, what is commonly known as the "hair pin" return bend is coming into style. These "hair pin" bends are made of extra heavy wrought pipe bent to any distance centers and made in any length from bend to end of pipe. By their use the flanges may be put in any convenient place instead of in inaccessible places as would often be necessary with the regular cast return bend. When "hair pin" bends come from the factory the flanges are sweated on if so desired. As long as pipe and flanges are to be ordered from a shop handling ammonia apparatus it is always best to have the flanges put on, as the factory is fully equipped to do such work in a tight and workmanlike manner.

In ice or brine tanks where the coils are submerged and hard to get at, I am a believer in the sweat work unless welded coils can be had. The welded coils are to be preferred wherever it is practicable to install them.

For exposed work and direct expansion piping the litharge joint is all right and will be found to give no trouble if properly erected. As for having to move flanges to get them in line, that is something which should not be done and will not have to be if proper care is taken when putting the flanges on the pipe. Square the flanges true in the first place. A man cannot sight along a 20-ft. length of pipe which is held in a vise and be sure that the flanges are square unless he uses a short straight edge or a piece of board. Place a straight stick at least 3 ft. long on the flange already made up and use a similar stick on the one being tightened. By doing this the flanges may be made true and square.

If for any reason a soldered or a litharge joint has to be disturbed, better take the flange or fitting off entirely and make it up over again. This is the only sure and proper way and will prevent future leakage.

If sweat work is desired, the flanges and the threads on the pipe must first be properly tinned so that the solder will stick. Then let the flange stay in the sweat pot until it is as hot as the solder. Make it up on the pipe while hot and you will really have a fit shrunk as well as soldered. The recess in the flange is also filled with solder, but this is only good in case of a small leak so that calking may be done. If a sweated joint leaks so that it requires calking it is not a good job and all that is holding the ammonia is the solder in the recess.

In making up litharge joints the threads in the flange and on the pipe must be washed clean with gasoline and the flange tried on to see that there are no defective threads. The flange should make up to within 4 threads of being through, by hand. Next mix only as much litharge and glycerine as will be used right away. Cover the threads of both pipe and fitting with the mixture, put on so that it goes into the bottom of the threads. Make up as tight as you consider proper and be sure to square up the flanges or fittings so that they will not have to be disturbed. The litharge should set hard in 5 min. at most in the ordinary temperature of a pipe shop. Litharge loses its strength (if it can be so called) by being exposed to the air and moisture and with age. Keep litharge in a closed bottle or can.

Another form of joint which I have used many times and which has proved satisfactory is just plain flake graphite mixed with cylinder oil. With good clean threads on the pipe and in the fitting it will be found that graphite and oil will make just as good a job as can be desired. It will be tight enough to stand 300 lb. air pressure test after several years of service and that is all that even a sweated joint will do.

On any exposed ammonia work and direct expansion piping I am always willing to take a chance on graphite, as I have tried it out fairly and know that it will hold. No matter whether solder, litharge, or graphite is used, be sure to have clean, sharp-cut threads and make up the proper distance, depending on the size of the pipe that is being installed.

On the discharge lines from dry gas ammonia compressors it is the custom to use sweat work. But I am sure that flake graphite and oil will do equally well. We often see all the solder on such joints (especially close to the compressor) entirely melted out, owing to the exceedingly high discharge temperature carried. Such joints are always showing signs of leakage by the presence of oil oozing out, but no ammonia seems to escape. For such places graphite is just as good as solder, for the simple reason that solder won't stay in with the high temperature that is sometimes reached.

Litharge and glycerine is also useless in such places. The changes of temperature from perhaps 100 to 300 deg. F., will crack the litharge and the vibration of the pipes will soon cause it to become a powder and fall out.

One claim made for sweated work is that the exposed threads on the pipe are properly tinned and will, for that reason, resist the harmful effect of rust. That is one point in favor of this style joint that no argument can do away with. But with a good grade of wrought pipe there is little more danger of failure at the threads than at any other place.—Valve World.

Suction Connections Need Rearranging

By A. J. Dixon

THE principal refrigerating equipment of a hospital consists of two 9½ by 16-in. double-acting ammonia compressors running 60 r. p. m. It is surmised that when the plant was erected, about 4 yr. ago, the designer expected either of these machines running alone to provide the necessary refrigeration at all seasons of the year. The manner of running the suction piping, shown in Fig. 1, suggests this. It has been found, however, that during very hot weather one com-

pressor is not only insufficient, but even with both machines running the result is sometimes inadequate.

These compressors are of the wet-gas type. When running them together, it has been found that if the 2½-in. stop valves in the suction branches are both wide open, most of the liquid-laden gas passes to compressor A; apparently only a very small portion of the liquid going to compressor B. The result is that the discharge side of compressor A becomes quite cold while the discharge side of compressor B runs inordinately hot, so much so as to melt the solder out of the threaded

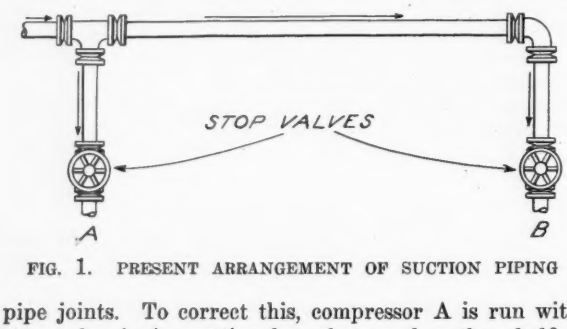


FIG. 1. PRESENT ARRANGEMENT OF SUCTION PIPING

pipe joints. To correct this, compressor A is run with stop valve in its suction branch open less than half a turn of the handwheel.

For all practical purposes, the weight of ammonia gas may be regarded as proportional to the absolute pressure of the gas. Within certain restrictions the potential refrigeration in a cubic foot of ammonia gas may likewise be regarded as proportional to the absolute pressure of the gas. Therefore, any reduction in the number of cubic feet of gas that a compressor displaces, or any lowering of the pressure at which the gas enters the cylinder results in proportionately reducing the capacity of the compressor.

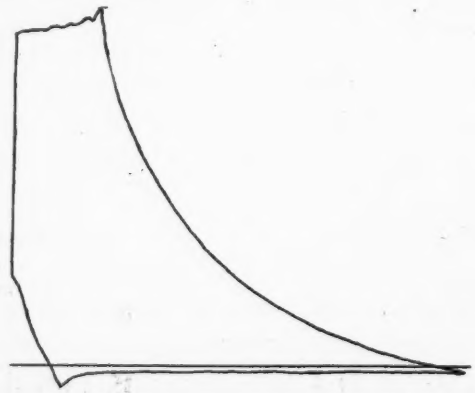


FIG. 3. CARD WITH STOP VALVE CLAMPED DOWN

In the diagram, Fig. 2, taken with the stop valve in the suction pipe wide open, the back-pressure line scales 11 lb. above the atmospheric line which makes the absolute back-pressure within the cylinder approximately 26 lb. The pressure in the suction line, as indicated by the gage, was 15 lb.; this corresponds to an absolute pressure of approximately 30 lb. Therefore, the drop in back-pressure between the suction line and compressor cylinder, due to frictional resistance in the valve passages, results in each cubic foot of gas representing only 26/30 = 87 per cent as much ammonia, by weight, as would have been drawn in had the entering pressure been 30 lb. absolute, the same as in the suction line.

In the diagram, Fig. 3, taken with the stop valve in the suction pipe clamped down, the back-pressure line scales 3 lb. below the atmospheric line, which makes the absolute back pressure within the cylinder approximately 12 lb. This is 12/30 = 40 per cent of the observed absolute suction pressure in the pipe. It is also only 12/26 = 46 per cent of the cylinder suction pressure obtained with the stop valve wide open. Therefore, with the two machines running together under

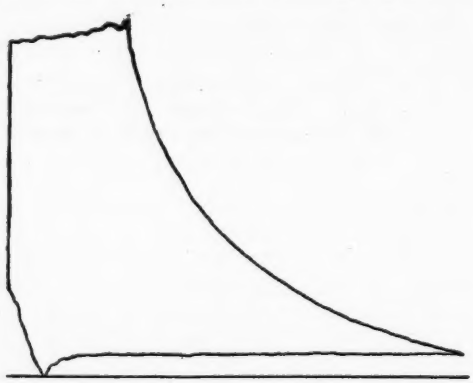


FIG. 2. INDICATOR CARD WITH STOP VALVE WIDE OPEN

present conditions, less than 75 per cent of the actual available refrigerating capacity is realized.

Very evidently, the remedy would be to run the suction line as shown in Fig. 4.

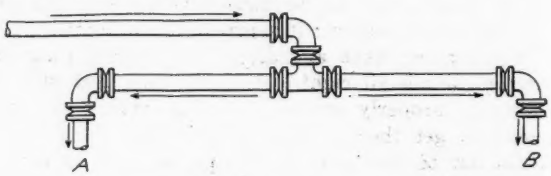


FIG. 4. HOW SUCTION PIPING SHOULD BE RUN

THE OUTBREAK some years ago of a tremendous gas jet at Neuengamme, near Hamburg, caused a temporary stir. We were under the impression that the gas had exhausted itself. But we find that the gas has been caught and, being mainly methane and not suitable for being mixed with illuminating gas in percentages exceeding 15 per cent, has been used as fuel in the Hamburg waterworks at Rothenburgort; 24 of the boilers there are fired with the gas, which is introduced under a head of from 10 to 40 cm. of water. The gas supply being unreliable, the grates were not interfered with, so that, in emergency cases, a return to coal fuel could be quickly effected. To check the air supply through the grate, the grate is kept covered with a layer of slag. In the 3 yr., August, 1913, to August, 1916, the pumping works used 18.8 million cubic metres of this gas, the gas consumption being 0.66 cu. m. per hp.-hr., and 15.2 m. of gas for raising 100 cu. m. of water to a height of 53 m. It is estimated that the use of the gas saved 22,400 tons of coal. In Torda, in Hungary, natural gas was adopted as domestic fuel last autumn, after having been utilized in four factories, the municipality and the natural gas company having entered into a contract, the company to supply the apparatus and connections.

Secondhand Apparatus

Some Costly Experiences With Used Machinery Which Failed. By H. A. Jahnke

THERE is much machinery in power plants and machinery used for manufacturing purposes that should be scrapped. But this is not all. Many times a secondhand apparatus is added to the equipment or to replace some machine which is worn so badly that it cannot be repaired; and it is a wonder to me how some of these concerns can exist with an outfit of this kind against up-to-date power and manufacturing plants.

Some plant owners and engineers believe that in buying secondhand apparatus they save money; but many times this apparatus is something someone else does not want, which means that it is worn badly or it is not worth having.

The writer has had much experience with employers who were in the habit of buying secondhand apparatus for the power plants as well as machinery for manufacturing. If a belt or any other material was needed, secondhand dealers or someone who had the apparatus on hand was consulted first. Then if the apparatus was about the size wanted, and cheap, it was bought. Many times in buying secondhand apparatus trouble is invited. Some experiences I had with secondhand apparatus may therefore be of interest.

Secondhand Friction Clutch

I remember one case in particular where some changes were going to be made on a belt drive from one shaft to another. To make the change a 60-hp. friction clutch was wanted. A secondhand solid clutch and pulley of the right size was located at a small machine shop and was bought at the low price of $60. When it arrived it looked good as it was painted up nicely to cover up any defects it may have had. The clutch and pulley was placed in the shop and there was no trouble for some time. In adjusting the clutch one day it was found that 2 of the 6 arms in the clutch spider were broken. A new spider was ordered at once at the price of $25. The next Sunday, in trying to remove the old spider from the shaft, it was noticed that many more of the clutch parts were broken so that it could not be repaired.

A brand new split clutch with a split pulley was ordered at once and placed the next Sunday, which is now about 5 yr. ago. There has been no trouble since. I believe it would have been much cheaper to get a new split clutch and pulley in the first place, as in placing the solid secondhand clutch it took three men two days, due to taking down pulleys and shafting and replacing them, also the plant was shut down one day with a loss of production.

Secondhand High Speed Engine

Another case was that of a 100-hp. high-speed engine which was purchased very cheap. When the engine was installed and ready to run it was found that it would not pull 40 hp., to say nothing of 100 hp. In taking off the steam chest cover and cylinder head it was found that the valve seat and valve cylinder and piston rings were cut badly. Two weeks were spent in reboring the cylinder, making new rings, facing up valve seat and making a new valve. Then it was found that the governor did not work right, as many of the pins were worn badly, so another week was spent on governor repairs. After that the engine ran fairly well, but was not what it was supposed to be. The engine was only run for a short time when it was sent to the scrap heap. Now, if we figure the time on repairs and material used on this engine besides the many shut-downs, I believe the loss of production would have paid for two new engines of this capacity.

Secondhand Steam Hammer

In another case, a secondhand steam hammer was bought. After examining all parts of the hammer it was found that the cylinder needed reboring, new piston rings were needed, the valve chamber needed facing up and a new valve, besides many other repairs, which took about 2 weeks' time. After the hammer was ready to run it was found that it used too much steam. Then another week was put in on repairs and adjusting; but the hammer never was what it should be.

Secondhand Steam Pump

For a plant where a boiler feed pump was needed a secondhand duplex pump was located in a machine shop which they said was in first class condition and they would sell it very cheap. The pump was a little larger than was needed, but was bought. When it arrived it was examined and nothing was found apparently wrong; then it was connected up. When ready to run, it was found that the ¾-in. steam valve had to be opened nearly wide to make the pump move. After it got started it could not be throttled enough without stopping, to furnish the right amount of water to the boiler. On close examination it was found that the steam piston and valves leaked badly, also the water cylinder being worn out of round causing a bad leak. To get the pump in good running order would have cost more than the pump itself so the pump was not accepted. A new one was bought of just the right size and for less than it would have cost to buy and repair the secondhand pump.

Secondhand Wood Split Pulley

A 60-in. diameter by 15-in. face wood split pulley being wanted, a secondhand pulley 60-in. diameter by 18-in. face was bought (also very cheap). After about six months' use the pulley started to go to pieces, when it was seen that the pulley had been patched, but was covered with paint so it was not noticed. In this case it would also have been much cheaper if a new pulley had been gotten in the first place.

I believe it is poor practice to buy secondhand apparatus for the power and manufacturing plant at any price, as one never knows what he is getting. Of course, I am aware there are exceptions, as in cases where the former owner has no use for a certain apparatus any more or has gone out of business. I prefer, however, to get new goods, as then I get just what I want and avoid trouble in getting a secondhand apparatus to work right, besides the many delays. But if anyone insists on buying secondhand apparatus it is good practice to have some experienced man who is not acquainted with the seller to examine it, then take his advice, and then think twice before buying.

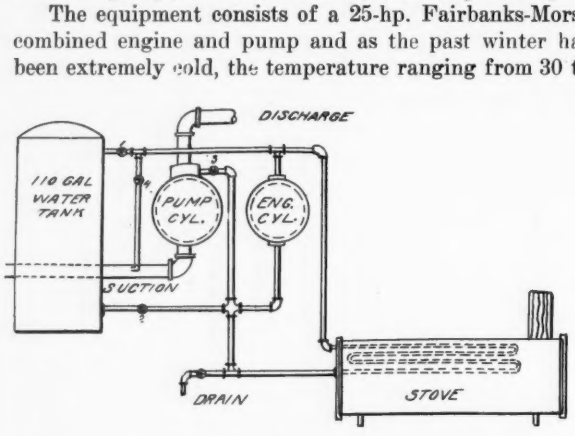
LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Warm Circulating Water for Gas Engine Cylinders

FOR THE BENEFIT of others who may at some time find themselves facing the same proposition, I am sending a sketch showing the arrangement of piping I installed in the Iditarod (Alaska) gasoline pumping fire station for the purpose of keeping the engine cylinder warm at all times and thereby insuring ready and positive starting. After starting, valves 1 and 2 are closed and valves 3 and 4 opened and the water taken directly from the pump; the rest, I believe, is self-explanatory.

The equipment consists of a 25-hp. Fairbanks-Morse combined engine and pump and as the past winter has been extremely cold, the temperature ranging from 30 to



ARRANGEMENT OF PIPING IN USE WITH COMBINED GAS ENGINE PUMPER

50 deg. F. below zero for weeks at a time, I have found this arrangement of great value. It works exceedingly well and at a great saving in fuel over air warming.

J. C. CURRIN.

Experience With Make-Up Water Tank

IN ONE PLANT with which the writer was connected, a big cast-iron tank was used for collecting all the hot drips from driers, steam coils, etc., and then any supplementary cold water necessary for making up the feed supply was introduced by means of a float controlled valve.

After being in operation for a time, one of the plates in the tank just below the cold water inlet cracked and had to be replaced. Shortly after the replacement was made, another plate adjoining the new one cracked and after another replacement cracked again, following which the idea of defective plates was given up and an investigation made to determine the cause of the trouble.

After carefully going over the layout, it was found that the cold water entering the tank was permitted to trickle down the side of the tank, the inlet piping being merely tapped into a boss near the top of the tank. It was then reasoned that this cold water entering the tank came in contact with the hot plates exposed to the hot return water, steam and vapors, and expansion and contraction strains set up which caused the cracking of the comparatively thin plates.

To remedy this defect in installation, a piece of pipe was tapped into the cold water inlet boss from the inside of the tank and a piece of pipe inserted which carried the incoming cold water out into the center of the tank so that it would be partially heated before it came in contact with the plates. A short piece of pipe and a 45-deg. fitting was used to divert the flow of the center of the tank, as shown in the diagram. After making these changes, no further plate crackage was experienced.

The crack in the last plate installed was patched as illustrated. A ½-in. hole was drilled at each extremity of the crack and two ½-in. holes drilled through the crack as shown. Then a plate on the inside and outside

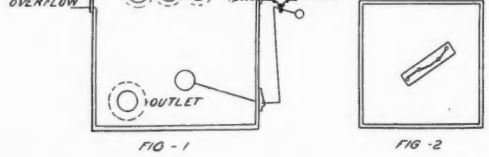


FIG. 1. METHOD OF INTRODUCING WATER TO MAKE-UP WATER TANK

FIG. 2. PATCHED PLATE

was placed over the crack and bolted tightly together with a red lead mixture, the bolts being pulled up through the four ½-in. holes. M. A. SALLER.

Peculiar Injector Performance

THE ARTICLES on injectors which have appeared recently in Practical Engineer, recall an experience I once had in a small packing plant. The boiler was fed with a small single-tube injector, the water entering the injector under pressure.

During the forenoon of my first day, I started, or rather I thought I started, the injector, as it acted normally and gave forth the usual sound which indicates proper operation. After a few minutes, I was called into the main building to find out what was the trouble with the cold water piping, as it was hammering and pounding like a boiler factory. Upon opening a tap, steam and hot water appeared. Guessing the reason, I ran to the boiler room and shut off the injector, which in-

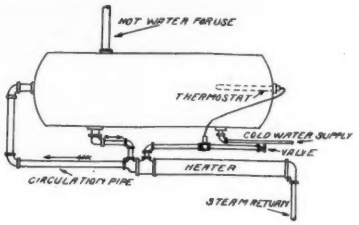
stead of feeding into the boiler, was, in fact, backing up into the supply line. An investigation showed that this trouble had been experienced before and was caused by the street sprinkler having drawn water from tanks supplied by the same water system, which, because of the normal low head and small pipe size, caused our end of the system to lose its pressure entirely, and permitted the steam to blow back into the line. As it was absolutely necessary for me to get water into the boiler, and quickly at that, I grabbed a bicycle and rode a half mile to the first tank, and as there was no stop valve in its feed line, I had to climb on top and tie up the float.

The water pressure was on now, and the injector worked in the right direction. I placed a check valve in the water line, and by timing the sprinkling cart and my boiler feed, I was able to prevent a recurrence.

A. C. McHugh.

Water Heating in Closed Tanks

It was with considerable interest that I read the article bearing the above caption, as published on page 311 of the April 1 issue of Practical Engineer, and believing that the readers may be interested in similar schemes employed in the heating of hot water, I am submitting the 2 sketches shown herewith. That illustrated in Fig. 1 is used to heat water in an office where 84 people are employed and has been in service 3 yr. without causing a bit of trouble. It is made up of a special copper tank provided with a thermostatic regulator and heats the water to 160 deg. F. (71 deg. C.).



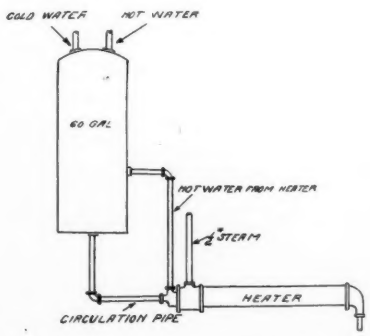


FIG. 1. THIS SYSTEM EMPLOYS A SPECIAL COPPER TANK WITH THERMOSTATIC REGULATOR

FIG. 2. SYSTEM MADE UP OF A 60-GAL. GALVANIZED IRON TANK AND A PERKINS HEATER

The other, Fig. 2, consists of a 60-gal. galvanized-iron tank and is used to furnish all the hot water required by 100 men working in an industrial establishment.

Both systems employ a Perkins heater built by the Oliver and Howland Co., of Springfield, Mass.

H. Armstrong.

Bending Large Pipe

When installing a mill engine in an outlying district, I was confronted with the problem of making an offset bend of 6-in. pipe of the dimensions shown in Fig. 1.

A large stock of raw material of a perishable nature was in the mill, the piping was unfinished and a 48-hr. delay in sending to the nearest foundry would mean large losses.

A stock of 6-in. pipe was on the ground. The village horse-shoeing shop afforded us a hand forge, a few sacks of blacksmith coal and some logging chains. I found a 1-ton chain tackle in the mill, and we made up the rig shown in Fig. 2.

The sleeve and nipple shown were screwed on one end of the stock piece, to lengthen the end and protect the threads. A block of 8 by 8-in. timber 2 ft. long was dressed to fit the pipe, as shown at A, while the tackle was chained to each end of the pipe.

It was unnecessary to remove the pipe from the fire while tightening the tackle. A cherry heat was kept all along the outside of the bend during the operation, the convex side of the curve being kept a cherry red while the concave side remained almost black.

This manner of heating prevents kinking, which is caused by the fact that with an even heat all around, the metal on the inside of the bend is upset and distorted more readily than the metal on the outside of the bend is elongated.

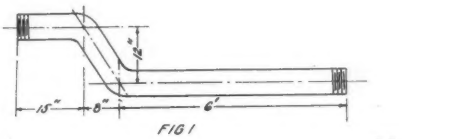


FIG 1

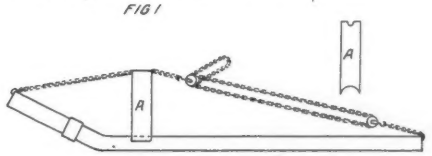


FIG 2

FIG. 1. DIMENSIONS OF OFFSET DESIRED

FIG. 2. METHOD OF MAKING THE BENDS

By pulling slowly on the tackle and moving the pipe along a few inches in the fire after each slight bending motion, the stretch was evenly distributed over the bent area.

The two bends were thus treated alternately, the entire job taking 4 hr. to complete.

H. K. Scholefield.

Extending the Steam Pipe

About 8 yr. ago, it became necessary to install a new 72-in. by 18-ft. high-pressure return tubular boiler to take the place of 2 small boilers which were about worn out; it was not safe to carry the pressure needed for the engine to pull the load, as this boiler was to be located a longer distance from the engine than the two old boilers. (This was necessary, as the old boilers could not be pulled out before the new was in service.)

The header on the old boiler and steam pipe to the engine (which is a 16-in. by 32-in. single eccentric

Corliss, 85 r.p.m.), was 4½ in. As the new boiler was located much farther from the engine, I thought a 4½-in. pipe all the way from boiler to the engine would give too much pressure drop. So I decided to run a 6-in. pipe from the boiler to the 6 by 4½-in. elbow leading down to the engine throttle as shown in Fig. 1. Figure

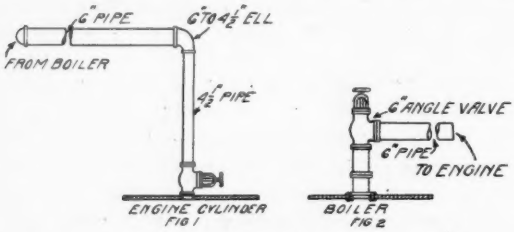


FIG. 1. REDUCING CONNECTION AT THE ENGINE
FIG. 2. CONNECTION AT THE BOILER

2 shows the arrangement of pipe on the top of the boiler. After all pipes were connected and the engine was in service, it carried the load nicely. H. A. JAHNKE.

Peculiar Result of Sand Blast Action

THE CAPSCREWS shown in the accompanying illustration were selected at random from several dozen which were used to fasten the casing on a 36-in. exhaust fan used in connection with a sand blast for cleaning castings.

In due time, the action of the sand wore the blades of the fan almost through, and on one blade entirely so. This action was noticeable on the casing, which was as thin in several places as paper.

The ½-in. capscrews, by means of which the casing was fastened together, projected inside ½ in. or less and naturally came in contact with the sand blast, which gradually wore away the stock until in three or four

RESULT OF SAND BLAST ACTION ON CAPSCREWS

instances the capscrew was worn off flush with the sheet or frame. However, the peculiar thing is, that the blast of sand wore away the thread equally all around into irregular shapes, preserving the pitch of the thread accurately up to the last, as can be seen.

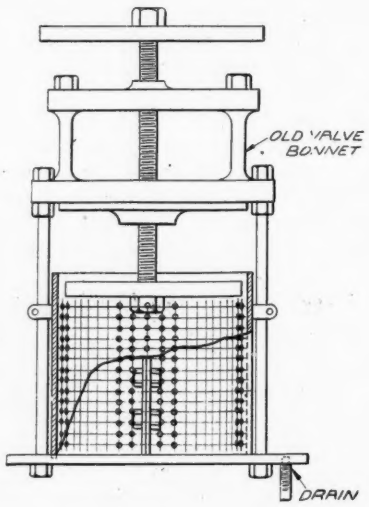
The fan had been in service about 2 mo. daily and was new when placed in service. GEO. H. WALLACE.

Waste Press

A SMALL waste press for use on the bench can easily be constructed if one has an old valve bonnet in the scrap pile. The other materials, some round stock and plate iron, almost all plants have.

Take out the old valve stem, and retap the valve yoke for as large a screw as it will permit. Use a standard tap and die for this work of fitting the screw.

Make a base out of a piece of boiler plate. The box or waste container is square in section, and can be easily formed up out of ⅛-in. sheet iron. Cut a groove with a cape chisel in the base for it to rest in. The illustration is self-explanatory; no measurements are given, as it can be made to suit whatever size valve bonnet one



WASTE PRESS MADE FROM OLD MATERIALS ABOUT PLANT

might have. A groove should also be cut around the base to catch the oil and this led to a drain pipe tapped in the base. C. H. WILLEY.

Removing Piston Rod Packing

HERE IS a little stunt that may be of benefit to some of our readers. To remove packing from the stuffing-box of an engine that you can turn over by hand, place the engine on dead center, with crank toward steam end, close the cylinder cock nearest to crank end of engine, then give the engine ½ turn quickly. The compressed air in the cylinder will blow the packing out. It is safer than blowing packing out with steam, and will leave your rod and box cool to work on. Of course, when you turn the engine you must be careful not to jam the gland.

E. J. DOWD.

Starting Pump When Stuck; Pump Plunger Leaks

HAVE YOU ever watched a fireman or oiler try to start a stubborn pump with a crowbar? Maybe you have done this yourself.

If so, next time simply slip the bolt out of connecting valve rod and stem and move the valve to the opposite end of stroke; the plunger will move and no bar will be required.

After having overhauled our 2 center-packed plunger pumps, we discovered pin hole leaks in both plungers. These we readily repaired by drilling and tapping the plungers and inserting a threaded brass plug; after a snug fit was obtained, the plug was sawed off and smoothed over. As a result the leaks were stopped. J. C. LEE.

Successful Kinks From The Plant

For Saving Time, Work and Trouble

Rocker Arm Repair

THE ROCKER ARM which opens the exhaust valve on our Stover gasoline engine had worn so that it allowed the spark trip (which is carried on the connecting rod of the above) to miss engagement with the trip lip on the spark plug, or make and break, as you may call it. We had no new one and no time to get one, so tried the following scheme, which worked to perfection, and the good of it is, can do it over and over.

We happened to have a short piece of ¾-in. brass pipe, the size of the pin in the rocker arm. I drilled the hole in the rocker arm out to 1 in., made a bushing from the brass pipe, which was a little over 1 in. outside measurement, so split the bushing with a hack saw, taking out just enough so that it would be a good tight fit in the rocker arm. Then, of course, the inside was smaller than 1 3/16. I tried to drill it with an ordinary twist drill, but failed, as the difference in size was so small that the drill would "dig in"; consequently we were "up against it." I simply filled the inside of the bush with babbit and centered it carefully, using the same method as for centering shafting. The drill then went through, leaving the bushing as smooth as a reamer would. Then, drilling the oil hole and scraping the rough edge from the inside, the result was perfect. It has been on for 6 mo. and is still working.

A. P. SITTON.

Fuel Oil Strainer; Peep Holes

OUR FUEL OIL was so bad at times that we could hardly use it, so it led me to make a strainer or filter. I had a carpenter make a box 2 ft. wide, 2 ft. deep and 6 ft. long. This was made out of 2 by 6-in. tongue and groove flooring. The box was lined with tin, the top being bolted on so as to be convenient to clean out. Next I had a box made out of 1 by 12-in. board, 18 in. wide, 18 in. deep and 5 ft. long, which went inside of the other box and was bored full of 2-in. auger holes on top, bottom and sides. Inside of this box we tacked gunny sacks for filtering material. We then had 2 3-in. holes bored in the outside box at opposite ends, one for intake pipe, from car, and the other to discharge the strained oil to the storage tank. The intake pipe extended into the smaller box and fastened there with a flange. The discharge pipe was fastened to the outside box only, as it served to catch and carry off strained oil.

When our filter gets full, as it generally does about twice a week, we undo the bolts, open both box tops and clean it out in a few minutes.

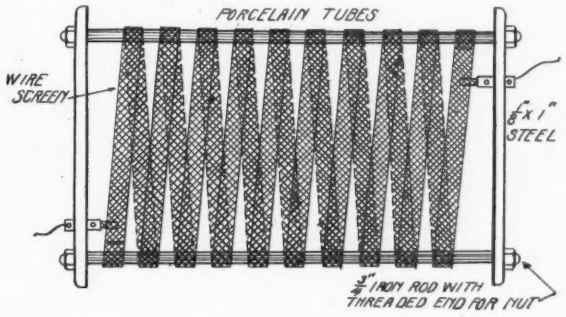
Of course, for a very large installation I would recommend making the outside box of concrete. This saves a lot of dirty as well as dangerous work of cleaning out storage tanks. Likewise the firemen pass along the thanks.

In making peep holes, I find a good way is to brick up doors as usual and make some nipples out of 4 or 6 in. pipe, cut them at about 20 or 30-deg. angle and take some strap hinges, 3-in. will do, make a small door to fit this, say ½ larger, so it will flap down on the pipe nipple, the draft will hold them shut and exclude all air. Also you can wedge the brick in tight and make more of a permanent job out of it.

FRED V. BROADAWAY.

Emergency Electric Air Heater

RECENTLY we had occasion to make up an air heater for warming a certain room, since it was found impossible to secure delivery of a standard heater in time. It was made up in a simple and inexpensive way as follows: Ordinary window or door wire screening of a good grade was used for the resistor. It was cut into strips 1 in. wide and made up to a length of 100 ft. The frame was made as shown in the accompanying sketch, of two ¾-in. iron rods threaded at the ends for



INEXPENSIVE EMERGENCY AIR HEATER

receiving nuts. The end pieces were ⅛ by 1-in. steel flat bars drilled at the ends to slip over the threaded rods. Porcelain tubes were slipped over the side rods for insulating them. One end of the resistor wire ribbon was fastened and then the ribbon wound around as shown and the other end also fastened by wire. Where the ribbon passed over the tubes a piece of screen ribbon was first wound underneath and clear around the tube; this was to give added current-carrying and radiating surface at these points so as to prevent overheating and possible cracking of the porcelain tubes. The leads were No. 12 wire and passed through insulators in the end bars and were securely wound about the resistor ribbon near its end so as to make a good electrical terminal connection.

This heater was connected to a 220-volt circuit and took about 4 kw. It heated the room in which it was used quite rapidly. It was put on a separate circuit with cutout and knife switch. While in use, the heater

was placed on horizontal framework so as to support it at the ends in a horizontal position, thus permitting a rapid circulation of air which accounted for the effective heating service it furnished. The heater was surrounded by a simple pipe guard connected to the supporting framework to keep anything from coming in contact with the heated element. Although very crude in appearance, the heater served its purpose well until warmer weather returned.—B. C. ZIMMERMAN, IN ELECTRICAL REVIEW AND WESTERN ELECTRICIAN.

An Extra Bench Vise

OFTEN when doing some overhauling, an extra vise on the bench would save a lot of waiting for the other fellow to get through. This is just the sort of a vise for filing liners and small work and can be made from materials that you have about the plant.

The illustrations are self-explanatory, but a few remarks might help. The hole at A, Fig. 1, is tapped for the jaw screw. The bolt at B is adjusted so that the jaw slides with ease. Then drill a hole through

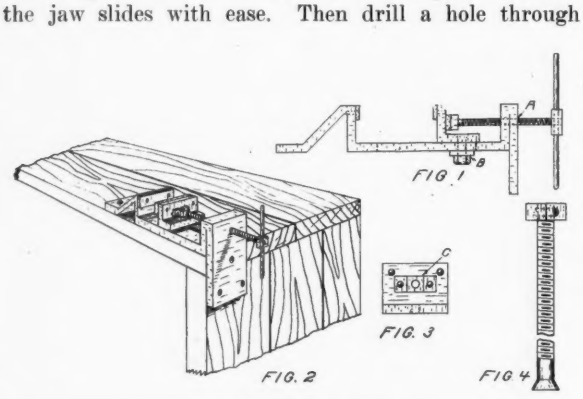
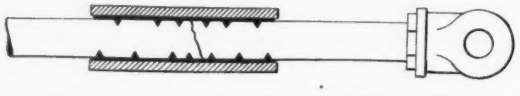


FIG. 1. ELEVATION OF BENCH VISE WITH PARTS ASSEMBLED
FIG. 2. PERSPECTIVE VIEW OF VISE ATTACHED TO BENCH
FIG. 3. DETAIL OF MOVING JAW
FIG. 4. SCREW USED IN VISE

the nut and use pin to secure it. A slot or groove has to be cut in the bench for this—a slot is best, then no dirt will bother. The jaw screw is put in, and the piece at C, Fig. 3, is slipped on the bolt, Fig. 4, and the end peened over. There are no measurements given, for the size depends on the material you may have, and the width of opening desired. C. H. W.

Emergency Repair of Eccentric Rod

SOME TIME AGO, the writer was engaged in starting a power plant and after all the engines and compressors had been lined up, the men who were drawing up some flanges in the pipe line above one of the compressors



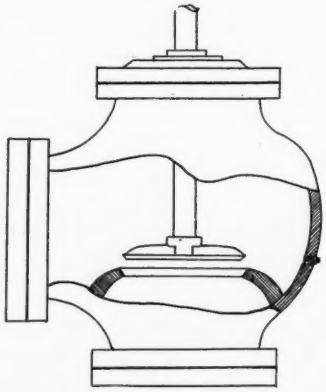
ECCENTRIC ROD WITH EMERGENCY REPAIR

dropped one of their heavy wrenches on one of the small machines, which snapped the eccentric rod operating the steam valves. The plant was ready for starting up and it was therefore impossible to secure a new part from the manufacturer. We did not care to braze or weld the rod because that could not be done without affecting its length, which meant readjusting the valves. One of us hit upon an emergency repair as illustrated which served the purpose in every way and saved the necessity of resetting the valves.

To make the repair, the rod was nicked with a file for a distance of about 3 in. each side of the place where the fracture occurred and then a piece of 1-in. pipe about 7 in. long was placed over the rod in this locality, acting as a loose fitting sleeve. After properly centering the pipe sleeve the space between the rod and the pipe was then filled in with heavy babbit, which was poured in hot. The babbit naturally flowed into the crevices filed into the rod and as a result a good tight joint which could resist the pull of the eccentric was secured and this makeshift arrangement worked entirely satisfactorily until the plant could be shut down and the new rod installed. M. A. SALLER.

Cleaning Seat of Overflow Valve

WE HAD considerable trouble with leakage of the float controlled overflow valve on our open heater because of the accumulation of pieces of scale, oil clots., etc., on the seat of the valve, preventing it from seating properly and tightly. Every time this occurred, it became necessary to cut the overflow out of service and remove the bonnet of the valve which necessitated disconnecting the float levers, etc.—a time-taking and tedious operation especially when at times the valve would stick once every week or 10 days.



TAPPED OPENING IN FLOAT VALVE FOR CLEANING SEAT

We finally hit on the scheme of tapping a 1-in. opening in the body of the valve in the vicinity of the valve seat so that a scraper could be inserted and the oil and accumulation wiped off the seat without the necessity of disconnecting or dismantling the valve. When not in use, the tapped opening was closed by means of a standard square head plug.

This arrangement saved tremendously in time and labor, while it enabled more frequent cleaning of the valve seat than would otherwise have been possible.—A. W. L., IN REFRIGERATING WORLD.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Frost Formation on Ammonia Condenser Pipes

THE PLANT I am operating has a 5-ton Frick compressor, with double pipe condenser, electric drive on the brine circulation system, and operates a can plant and 3 cold storage rooms. I have had comparatively little experience in operating refrigerating machinery, but seem to be getting along all right with one exception.

Some time after pumping back the ammonia, but not at any particular time, the gage glass on the ammonia receiver shows a considerable number of large bubbles rising from bottom to top, and just afterward the receiver and the lower pipes of the condenser will begin to sweat and will soon form frost. By starting the compressor, the sweating and bubbling ceases at once. The condenser has been purged and the oil trap kept empty, and the system is pumped back to zero at all times before closing.

Will you kindly tell me whether this is all right, and if it is not, what danger is involved and how the difficulty may be overcome? E. A. C.

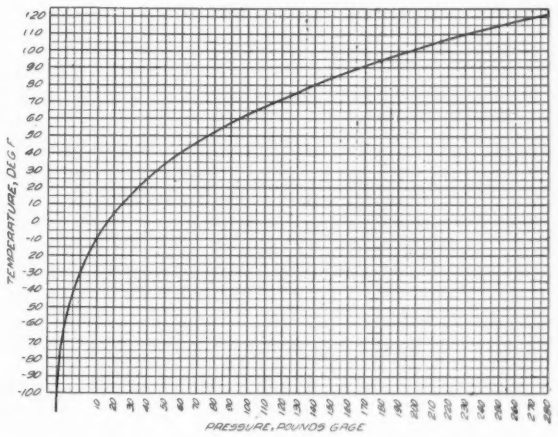
A. Whether a pipe or other part of a refrigerating system frosts or not is only a matter of temperature. It may be assumed that there is always sufficient humidity in the air to furnish material for the small ice crystals we call frost if the temperature of the pipe or other part with which it comes in contact is below 32 deg. F. Incidentally, the amount of frost deposited will depend on the amount of moisture in the air, and how much the temperature of the object is *below* 32 deg. F.

Frost, then, indicates accurately only one thing—namely, that the temperature is below 32 deg. F. The reason for the occurrence of frost producing or lower temperatures can best be explained by means of a curve which represents the variation of boiling temperatures of liquid ammonia with varying pressures.

Assuming that a receiver, an ammonia gage glass or the bottom pipes of an ammonia condenser contain liquid ammonia, that liquid will lie in a quiescent state as long as it is under a sufficient pressure to liquefy it at the temperature of the cooling water supplied to the condensers.

If the cooling water temperature is 100 deg. F. as it leaves the condenser, the pressure cannot be expected to be less than 200 lb., for 100 deg. F. is almost the boiling point of anhydrous pressure at 200 lb. gage pressure, as indicated by the curve. Conversely, if the pressure on the liquid ammonia in the bottom coils of the condenser, the receiver and gage glass is under 200 lb. gage pressure, it cannot be expected to boil at any temperature below 100 deg. F. If the temperature of the air surrounding the gage glass is much above 100 deg. F., however, or sufficiently above 100 deg. F., so that the liquid inside is raised in temperature above 100 deg. F., it will begin to boil, probably slowly, as evidenced by large bubbles of gas rising through the liquid column in the glass.

Although the liquid is boiling—that is, evaporating—it does not produce cold because the pressure is too high. If, however, the compressor be shut down so that the condenser pressure drops materially, the ammonia will be capable of boiling at successively lower temperatures corresponding to the decreasing pressures as indicated by the curve. Thus, at 95 lb. pressure the ammonia may be expected to boil, as will be evidenced by rising bubbles, if the temperature of the surrounding air is sufficient to heat it to 60 deg. F. or more. At 75 lb. 50 deg. F., and so on until if the condenser is sufficiently



PRESSURE-TEMPERATURE CURVE, SHOWING THE VARIATION OF THE BOILING POINT TEMPERATURE OF ANHYDROUS AMMONIA UNDER DIFFERENT PRESSURES

cold to allow the pressure to drop to 45 lb. or lower the ammonia will boil at a sufficiently low temperature, as indicated by the curve, to chill the pipe, receiver or gage glass to 32 deg. F. or lower and produce frost.

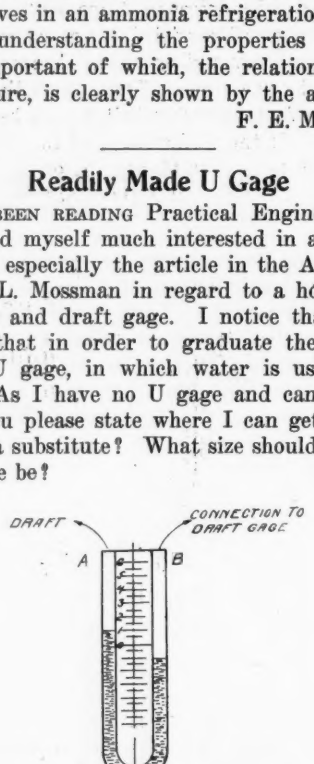
It is apparent that frost may be expected to appear wherever the pressure to which liquid ammonia is subjected is less than 45 lb. gage, and that boiling manifested by bubbling but not by frosting may occur at any pressure whatsoever above 47 lb. gage, the only requisite being that the local part where the boiling occurs is sufficiently isolated from the main body of the liquid to allow it to get slightly warmer than the main liquid.

Obviously the reduction of pressure necessary to produce frosting may occur in many ways besides cooling the condenser. Frosting will occur in the condenser if the machine is reversed and the condenser "pumped out," as is done when repairs are to be made. If the receiver is open to the condenser and the ammonia is to be stored in the low-pressure side of the system, the frosting will extend to the receiver, or if the expansion coils are pumped out and the ammonia stored in the condensers which are valved off from the receiver and there should subsequently be a slight leakage through the receiver valve into the expansion coils, thereby relieving the pressure in the receiver, or in case the receiver is connected to the expansion coils so that it also is pumped out with the coils, it may be expected to frost just as an ammonia shipping drum frosts when its contents have been practically all discharged into the low-pressure side of the system in which the pressure is maintained below 45 lb. gage.

The easiest means of meeting the problems that present themselves in an ammonia refrigeration plant is by thoroughly understanding the properties of ammonia, the most important of which, the relation of pressure to temperature, is clearly shown by the accompanying curve. F. E. MATTHEWS.

Readily Made U Gage

I HAVE BEEN READING Practical Engineer for some time and find myself much interested in a great many articles, and especially the article in the Aug. 15, 1916, issue by R. L. Mossman in regard to a homemade flue gas analyzer and draft gage. I notice that Mr. Mossman states that in order to graduate the draft gage, a common U gage, in which water is used, could be employed. As I have no U gage and cannot find one here, will you please state where I can get one or how I can make a substitute? What size should the opening in the U gage be? H. K. A.



U GAGE FOR DRAFT GAGE CALIBRATION

A. In reply to your inquiry relative to the homemade draft gage, it may be stated that the U gage which is employed to give a visible difference in pressure and calibrate the draft measurements, may be of any convenient sized glass tubing, although ¼ or ⅜-in. is a good diameter.

To make a U gage, a length of about 14 in. is bent at the middle while exposed to a blow torch, and a scale calibrated in inches is fixed between the 2 sides, the zero being set about midway between the top and bottom, as shown in the accompanying sketch. A sufficient quantity of water is poured into the U gage while in an upright position to bring both levels at zero. By drawing upon side A until the water rises to the 1-in. mark, a 2-in. draft is obtained, and when a connection is made to the draft gage, the corresponding 2-in. calibration may be noted as explained in Mr. Mossman's description. W. P.

Pressure of Ice

PLEASE ADVISE me if you have any data on the maximum pressure exerted when water is frozen. S. R. B.

A. In regard to the pressure exerted by ice, there seems to be little data available. The following information will probably give you an idea of what you want to know, however:

The expansion of ice at 32 deg. is 8.55 per cent; that is, the volume of the ice is 8.55 per cent greater than that of the water from which it is formed.

Experiments made at the University of Illinois in 1895, on the crushing strength of ice, showed that at 12 deg. F. natural ice, in the direction parallel to the original water surface, had a crushing strength of 1070 lb. per square inch, and with a pressure perpendicular to the original water surface, 1845 lb. per square inch. There is a wide variation, however, running 50 per cent above and below these mean figures, the lowest figure being 318 lb. per square inch, and the highest 2818 lb. per square inch.

For manufactured ice, tested at 23 deg. F., the crushing strength was 620 lb. per square inch, and at 14 deg. F., 906 lb. per square inch.

It is apparent, therefore, that the pressure which would be exerted depends on the temperature of the ice, and would be considerably lower at the time of formation, when the temperature is just below 32 deg., than it would later, as the temperature drops.

There seem to be, however, no data available on just what pressure ice will exert as it freezes from the liquid. A. L. R.

Cost of Operating Air Compressor

CAN YOU give me the approximate cost of operating a 9½ by 9½ by 10-in. Westinghouse air compressor for 10 hr.? The amount of air consumed by the machine for which it is furnishing this air is 460 cu. ft. free in 10 hr.

What does it really cost to operate this compressor under fair conditions? R. M. D.

A. We find by referring to a Westinghouse catalog that a 9½ by 9½ by 10-in. steam-driven air compressor has a displacement of 49 cu. ft. per minute when running at 120 strokes per minute.

The indicated horsepower with steam at 100 lb. pressure, and air delivered at 85 lb. pressure is approximately 21.5 hp.

You state that you will require 460 cu. ft. of free air in 10 hr. If the air compressor is operated at full capacity for 10 min. a day, it will supply you with sufficient air.

The cost of coal for operating this compressor 10 min. would not exceed, under reasonable conditions, 10 cents. R. E. T.

Settling Boilers

IF YOU DISCOVERED that a horizontal return tubular boiler had settled at the rear end, what would you do and what precautions would you take to keep it in operation?

2. How can you tell whether a horizontal return tubular boiler has settled at either the front end or the rear end?

3. What would you do if you discovered that the boiler had pitched forward?

4. How could you tell whether the boiler had pitched forward if it was empty?

5. Where would you first notice a forward or rearward pitch of a boiler? W. F. R.

ANSWERS

WHEN YOU DISCOVER that your horizontal return tubular boiler has settled at the rear, you should take the earliest opportunity to restore it to its proper position, as such an occurrence is dangerous and a continuance will result in straining the piping attached to the boiler and in many instances will cause a rupture, with danger to the attendants and building, if not an explosion.

The method of restoration depends somewhat on the manner in which the boiler is set. If the boiler is suspended from the top with supporting rods, by tightening the nuts the boiler can be brought to its proper position; but if a boiler with this style of support settles any, without any change in the position of the nuts on the rods, it shows that the columns which form the supporting medium have settled on the foundation, and in this case, before attempting to re-set the boiler, you should look for the cause of the trouble and remedy it.

It may be that the foundation has settled owing to poor soil, as will sometimes happen where the boiler is located on made land. If it is impossible to renew the foundation owing to lack of time, or for other reasons, do the next best thing and put a footing under the bottom of the columns.

By means of blocking and jacks, raise the boiler to its proper position and take the weight off the supporting rods. Then remove the columns, and by using large plates, channel irons, short pieces of railroad iron or I-beams, make a footing sufficiently large to cover considerable of the foundation, which will distribute the weight over a much larger area.

One cannot advise definitely as to any case without knowing more of local conditions, and you will have to use good judgment in the matter. In case that it is impossible to shut down just at the time to do the repairing, and in order to keep running, use strong timbers and jacks to assist in supporting the columns, and thus increase the footing. If you can brace the columns well, then you can adjust the nuts on the supporting rods and bring the boiler back to normal condition until such time as you can make permanent repairs.

As far as possible, try to relieve the strain on the piping by adjusting it, if you can, by whatever means circumstances will permit. When a boiler is in an abnormal condition, bear in mind that there is a strain on the piping; and when blowing down under pressure, rig up some means of operating the blowoff valve from a distance and eliminate a certain element of danger.

2. When a boiler is cut out for washing or repairs, one has the best opportunity of learning definitely whether the boiler has settled at either end. If low at the front, water will stay there when the boiler has been emptied. If low at the rear end, by closing the blowoff valve and letting in a little water, you can see just how much water is at the rear end when the plates are just covered at the front.

If the boiler has a full flush front, and the front is plumb, you can note inside the front end where the extension sheet has begun to break away from the front plates, and can tell whether the boiler is low at the back or the front. A plumb laid on the front head will tell also, and possibly you may be able also to place a level on some of the nozzle flanges on top of the boiler.

3, 4 and 5. Owing to the continual expansion and contraction of a boiler, it is apt to pitch one way or the other if not properly set, and especially so if the boiler be placed with the rear of the setting up against a partition wall, in which case it will pitch forward, if the boiler setting is bricked up solid against the wall—a mistake sometimes made by masons.

The strain of the piping, if no allowance is made for expansion will influence a boiler in pitching, depending on the direction of the strain. The condition of the brickwork, and the cracks in it, especially around the lugs, will indicate the direction of pitch, and you can also tell by the condition of the front. If the movement is forward, the front will be bulged somewhat, and if to the rear, there will be a space between the front of the extension sheets (or of the shell itself) and the front.

Good judgment must be used in these matters, as has been said, and by giving them careful thought, one can determine the trouble and the proper remedy.

G. H. WALLACE.

Increasing Boiler Efficiency

WILL YOU kindly tell me the instruments required to obtain the necessary information upon which to work for increased boiler efficiency? This is in reference to a particular installation of Stirling water-tube boilers in which there is much leakage in the settings, at the clean-out doors and the blowoff valves; the boiler tubes are quite dirty and the steam piping is not properly covered.

Also give me a few practical points on the proper use of such instruments. J. C. L.

A. You undoubtedly want to know the simplest possible equipment with which you could make tests that would enable you to increase boiler plant efficiency. This is, of course, a somewhat different problem from securing the best instrument equipment to maintain the most satisfactory operating conditions, and the simpler instruments will not enable you to get the refinement in efficiency that can be gotten with the more expensive outfit, but will serve well for the first revision.

With a leaking setting, the best method of testing out is to go over the setting with a candle, as you probably know, noting the points at which the candle flame is drawn in toward the setting, and marking these, usually with a white paint, so that they can be gone over and calked with asbestos rope, or plugged with asbestos cement.

Around the clean-out doors, it will probably be a question of fitting the doors to the frames carefully, as no form of cement here will last long under the conditions encountered. A leaking blowoff is a matter of watching for the leaks and taking such steps as are necessary to make the joints tight. Actual observation is about the only thing of avail.

As to the loss from lack of pipe covering, we call attention to treatment of this subject on page 25 of the Jan. 1, 1917, issue, which will give you the means of estimating your loss. There is no method of measurement which is of much value here, as it requires careful and prolonged testing to get any satisfactory results.

As to combustion and boiler efficiency, you will need a couple of U-tube draft gages, which may be made out of an ordinary glass tube, mounted on a backing board with rubber connection; you should have a testing outfit for determining the CO_2 in your flue gases, and a sampling bottle for drawing off samples of the gas, and if you have a feed pump, there should be a counter connected to this which will register the number of strokes, and scales for weighing the coal used, or some method for determining, with approximate accuracy, the coal fed to the boilers. If this feed is provided by a spout from overhead bins, and there are no weighing hoppers, it becomes a difficult problem to determine the coal consumption. About the only thing that can be done then, is to get a fairly accurate idea of the amount of coal which the hopper will hold when it is filled to the ordinary height, then keep track of the number of fillings of each hopper. This is a rough method, but gives some basis to work on, which is better than none.

The pump counter will give you a fairly good idea of the amount of feed water supplied, keeping track of the number of strokes over a given period, the same as that for which the coal supply is measured, and figuring the pump displacement, allowing for 10 per cent slip.

The first proposition would probably be to determine the effect of the dirty tubes, keeping track of your water and coal consumption for a given period under ordinary operating conditions, to get the approximate evaporation of water per pound of coal. Then give the tubes a thorough cleaning and run a similar test, having the tubes blown off or kept as clean as possible in other ways, to determine the saving in coal used and the increase in evaporation per pound of coal due to cleaning the tubes.

The problem then comes of determining the best operating conditions—as to the depth of fuel to be carried and draft used. It will be necessary to put in ¼-in. pipe connections so that the draft may be taken in the ash pit under the grate, in the fire box above the fire, preferably at 1 or 2 points in the gas passages through the boiler, and in the breeching or uptake at the rear of the boiler.

In the book called "Steam," which was published by the Babcock & Wilcox Co., who now makes the Stirling boiler—on page 246 a chart is given showing the draft required for different kinds of fuel, with different rates of burning. You will find a reproduction of this on page 25 of the Jan. 1, 1915, issue of Practical Engineer, if you have a copy of that. You will also find shown on page 24, Fig. 2, approximately the way in which the draft should vary in the passes of a Stirling boiler when the boiler is in good condition, which will enable you to check up on your own operation.

You can now use the two draft gages in trying out the various operating conditions, connecting one into the combustion chamber above the grate, and the other one into the uptake. For a given thickness of fuel bed, maintain a certain amount of draft, approximately that shown by the chart referred to, in the fire box, and determine the evaporation per pound of coal over a period of 2 or 3 days, watching the draft loss through the boiler, meantime. Then vary the depth of fuel bed above and below this, changing the draft in the fire box correspondingly—in this way working out to see what depth of fuel bed seems to give the best evaporation per pound of coal. This should be checked at all times by tests of the carbon dioxide in the flue gases, to make sure that you are securing the best possible operating conditions. You will find this question of Gas Analysis discussed on page 77 of the Jan. 1, 1915, issue, and there have been some other simple forms of CO_2 testing apparatus described during the year 1916.

By such a process of elimination testing, you can determine, after a month or so of varying the conditions, what depth of fuel bed to carry and what draft conditions in the fire box give the best percentage of CO_2 for a given depth of fuel bed. With this determined, you can then regulate the feed of the stokers or the hand-firing process, so as to maintain the right fuel bed thickness and the right draft to secure best results. There should, of course, be check tests made of the CO_2, from time to time, to make sure that conditions are remaining as worked out in the first tests.

Of course, to secure complete control of operating conditions and know just what is happening, it is best to have some form of steam flow meter which will tell the steam output of the boiler. Then the fuel bed is regulated to the depth found most economical to produce this steam flow, and the draft is regulated to give the best operating conditions for that depth of fuel bed.

It is always wise to have the double-draft record—that from the fire box and from the uptake—because the draft in the fire box is an indication of the condition of the fire when the draft in the uptake is maintained constant. If the draft in the fire box falls, it is an indication of thin fuel bed or holes in the fire, or if it runs down gradually, it is an indication of clogging up of gas passages through the boiler, due to accumulation of soot and dirt.

We would advise you to go carefully over the issue of Jan. 1, 1915, and also the issue for Jan. 1, 1914, in which you will find this matter of instruments and methods of securing efficiency quite carefully discussed.

A. L. R.

Gas-Filled Electric Lamps

WHY ARE some electric lamps filled with hydrogen gas? READER.

A. The gas used in incandescent lamps is nitrogen, an inert gas, and not hydrogen. The effect of the nitrogen is twofold: First, it diminishes the surface evaporation from the filament; and second, the products of evaporation are carried to the upper part of the bulb. By this use of nitrogen it becomes possible to push the filament to a temperature of 2600 to 2700 deg. Centigrade, and to reduce the specific consumption to from 0.5 to 0.7 w. per mean spherical candlepower.

O. H. H.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

Is His Method Correct?

I WISH the readers of Practical Engineer would please tell me whether they have ever employed the following method of paralleling alternating-current generators and if so, whether they have ever experienced any trouble. I have worked under chief engineers considered first-class electrical men, but who could not give me any plausible reason for not using my method other than that they had never seen it done or heard of its being done.

In paralleling two alternators, the incoming machine is brought up to speed and the field exciter of the running machine adjusted until the regulator automatically stops. The relay reversing and the single pole disconnecting switches are opened and the alternator is under hand regulation.

The two exciters are paralleled, the field switch of the incoming alternator is thrown in and the voltage built up; the alternating-current machines are operating at the proper speeds as indicated by the synchroscope. Just before synchronizing, the regulator relay reversing and single pole switches are closed for the proper exciters being used, still leaving the exciter rheostats out and the alternators under hand regulation.

The alternators are then synchronized and then after each machine has settled down under its load, the exciter field rheostat is brought in and the regulator automatically starts and cares for the voltage.

I claim that the regulator acts as an equalizer much the same as the equalizing switch on compound wound direct-current generators. On the alternating current, the load equalizes and the voltage remains steadier with less movement of the rheostat than the direct current. What I mean by this is that the incoming machine, on account of being cooler, does not take all of the load as do direct-current machines.

I have used this method on steady loads and loads that vary greatly, with less trouble and considerably less voltage variation. Is this method harmful, and what damage is it liable to do? I have used it for years without any damage. R. A. F.

Can You Tell Him?

J. W. DICKSON has submitted the following questions with the request that we place them before the readers of Practical Engineer for reply.

If, in a Corliss engine cylinder, the points of cutoff are equal, is there any difference in the terminal pressure? Would there be any difference in the release lines?

Does changing the point of cutoff in the cylinder of a Corliss engine have any effect on the compression?

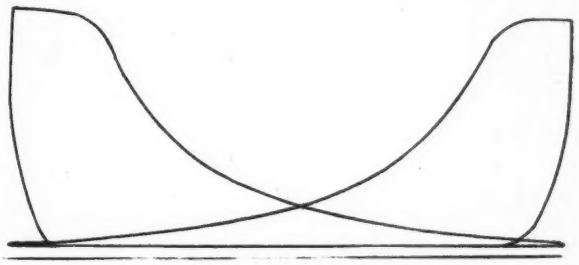
Does varying the cutoff interfere in any way with the smooth operation of an engine? If so, why?

Draw a diagram showing load variation on a Corliss engine. How does this diagram differ from that of a simple slide valve engine under similar conditions?

In order to maintain smooth and economical operation of an engine, would it be more practical to equalize the cutoff or to equalize the work done in the two ends of the cylinder?

Securing a Raise; Card to Criticize

WHEN A salesman meets a prospective customer he brings all influences he possesses to bear upon his customer until the sale is made. Having made the sale, in order to maintain his reputation with the customer, he must live up to his promises. This is good business. Selling our services as engineers should follow the same principles, yet I find it exceedingly difficult to secure an advance in salary which I think is due me for improvements I have made and good management which



CARD FROM HARRIS CORLISS ENGINE

have reduced operating expenses. Suggestions from those who have secured an advance in salary under conditions prevailing today should be of aid to me and others in the field. What arguments did you present and in what manner did you present them? On what basis did you make your claim for increase?

I would also appreciate criticism of the accompanying card taken from an 18½ by 42-in. Harris Corliss engine running at 82 r.p.m. THE CHIEF.

How May Corrosion Be Eliminated?

HAVING TROUBLE peculiar to the operation of a steam power plant, I am appealing to the readers of Practical Engineer for some suggestions.

I have two 150-hp. Bigelow return tubular boilers which show signs of corrosion and pitting of the tubes and plates. These boilers are employed to generate steam used at low pressure in heating water through an enclosed heater in a central hot water heating system. The boiler feed water is pumped from a receiving tank into which return and traps empty.

What is the cause of the corrosion and pitting? Can I eliminate it? If any of the readers of Practical Engi-

neer have encountered similar difficulty and have overcome it successfully, I would much appreciate hearing from them. W. S.

Is the Indicator at Fault?

AFTER STUDYING the indicator cards submitted by E. C. D. and reading his comments in May 15 number, I should think that the indicator told a true story of the conditions within his cylinders. If changing the spring tensions did not alter the shape of the cards, then the blame cannot be placed on the indicator unless the string is too long or too short, causing the indicator to hit the stop on one end or the other. This was evidently not the case, as the cards show no indications of restricted movement.

First, examine the top cards, which are evidently taken from an underloaded throttled slide-valve engine. If the engine were loaded to capacity, the card would run out straighter and at more nearly boiler pressure to the point of cutoff, after which there would be an expansion line more nearly the shape of the expansion lines from the Corliss engines shown below. With a slide-valve engine and a flyball or throttling governor, it is impossible to locate the point of cutoff on light loads, as the admission line will show the effect of throttling and will merge into the expansion line so gradually that there will be no sharply defined cutoff point, as in a Corliss engine, where the cutoff joint varies with the load. In the fixed eccentric slide-valve engine, the cutoff point does *not* change, no matter what the changes in the load may be. For that reason, the cards with light loads become triangular, as there must be a reduction in area and there are 3 points that do not change much with the load; the point of exhaust closure or beginning of compression; the pressure at the dead center, near which the admission begins; and the point at which the pressure reaches the normal exhaust pressure, generally soon after the piston has started back on the exhaust stroke. Thus it is that the only chance for additional power is in the admission and expansion stroke without change in the point of cutoff.

On the other hand, in the Corliss valve gear one of its advantages is the fact that the point of cutoff varies with the load, allowing practically full boiler pressure in the cylinder up to the point of cutoff. E. C. D. has overlooked this point because, he says, "Of course, I could advance the eccentric, making everything earlier; but that would make cutoff too early." When I first read this, I supposed that the valve gear on the Corliss engines was of the non-releasing type; but upon further study I found mention of dashpots, so conclude that E. C. D. forgot the fact that in the full Corliss gear the point of cutoff is independent of the eccentric, provided the load is within the range of the valve gear as set.

To return to the cards shown, I should say that there was considerable leakage in the "lighting engine," but where, cannot be easily guessed from the card. The higher exhaust pressure on the right-hand card would indicate valve leakage, while the reverse curve on the compression line would point more to piston leakage (in the case of a slide valve), although it might be caused by valve leakage. The fact that the right-hand card shows greater defects than the left-hand card would almost preclude the possibility of piston leakage. Piston leakage usually works both ways. I believe that if E. C. D. will remove the slide valve of the lighting engine, he will find defects in it at the end controlling the right-hand card. Aside from this leakage, the card is about what can be expected from a high-speed engine with a throttling governor, which is not much.

From the cards of the two Corliss engines, it can easily be seen that they were twin engines. The remarkable part about them is that the left-hand cutoff in both cases should be about the same and both longer than the right-hand card.

My advice would be to equalize the cutoff on both engines; that is, make the length of card of the point of cutoff the same on both ends. In doing this, it is important to have the load exactly the same while taking both cards.

E. C. D. is correct in thinking that the eccentric should be advanced. The release is too late on all 4 cards, and there is too little compression. If the ends of the cards start to slope outward when the eccentric is advanced enough to bring the release and compression lines to their proper form (indicating too early admission or too much lead), the ends of the cards can be brought back to the perpendicular by lengthening the steam rods. (It might be well to insert a word of warning here to anyone trying this for the first time: When you lengthen the steam rods, be sure to shorten the dashpot rods sufficiently or there will be a job for the repair man.)

The cards would indicate that the Corliss is pulling a rather heavy load for a single eccentric engine and there may be a possibility that at times of low steam or peak loads the steam valves would not release. Advancing the eccentric will shorten the maximum cutoff, that is, will make the gear fail to release at lighter loads; but, as stated above, within the range of the engine and gear the cutoff is regulated by the governor and not by the eccentric.

My advice to E. C. D. would be to keep the indicator and try some of the changes that occur to him and then see what effect they have on the cards. It is only by trying that the best results are obtained.

Another point to be remembered is that it is more difficult to get ideal cards on high-speed engines than on slow-speed engines; 110 r.p.m. is about the speed limit for Corliss valve gear of the releasing type. At that speed, an engine should have plenty of compression and lead to take the load of stopping the moving parts and not leave everything to the crosshead pin and crankpin.

C. E. MOULSON.

IN REGARD to the three cards shown by E. C. D. in the May 15 issue, in which he states that the defects in the diagrams are due to a defective indicator, I would suggest that before the indicator is condemned, he make sure that the trouble lies in the instrument, and not in the valve setting. A close examination of the indicator will show whether it is in proper working order, and the parts not sticking. The diagrams do not appear to be due to a defective indicator.

It is sometimes the case that a defective card is obtained, due to no defect in the instrument, but to the improper operation of it. There is nothing complicated or mysterious about an indicator. On the contrary, it is a very simple machine, and not subject to defects

except those due to deficient lubrication of the piston which may cause it to stick and give a defective diagram. Any instrument sent out by any reliable maker can be depended on to be reasonably accurate. If the accuracy of any particular instrument is questioned, it should be tested before being condemned. This may be done in the following manner. After taking a few cards from any given engine with the indicator in question, then without making any changes to the piping or valve setting, take a few cards with another indicator under the same conditions of load spring, pressure, etc. A comparison of the two sets of cards taken by the two indicators will show whether the indicator is at fault or not.

The principal source of errors in indicators is due to the piston sticking, and the spring not being accurate. The latter trouble, however, would affect only the height of the card, not its general shape. I would suggest that E. C. D. make this comparison of indicators before sending the new one back.

It is quite often the case that where a valve is set "by the marks," when the indicator is applied the results do not seem to be all that is expected. This may be due to any one of several causes such as lost motion of the various parts of the valve gear, which may be especially pronounced in a Corliss engine, due to the multiplicity of parts; angularity of the crank, eccentric and valve rods; inaccuracy of the marks on the end of the valves or ports or to inaccuracy in adjusting to the marks, or to a combination of two or more of these faults, which tends to magnify the results. For this reason, and from the data given on the valve laps, I believe the trouble lies in the valves rather than in the indicator.

E. C. D. states that there was no improvement after taking 200 cards, which I believe is good evidence that the instrument is in good order, and if properly lubricated could be relied upon. J. C. HAWKINS.

Bending Boiler Tubes

HAVING READ the different statements made by C. H. W., A. C. M. and G. H. W., I wish to state that having had the trouble mentioned and having renewed over 70 per cent of all the 4-in. tubes in the boilers in less than 2 yr., I have yet to see the first one warp downward. All those that came to my attention were warped upward and had two or three bends in them generally between the flame and baffles, as these baffles prevent the tubes from moving upward, being held by the rest of the 2-in. tubes that are not directly exposed to the fire.

This trouble has been remedied by using more boilers and eliminating forced draft for peak loads. Now, if there is any doubt about the tubes warping upward or away from the fire, let them explain why the side boxes and side tubes warp sidewise and not up or down. I have seen them warp almost 2 in., and by turning them halfway over, they have gradually warped back to their proper place.

C. H. Willey is puzzled that the tubes with the roof baffles do not warp upward; but this should convince him, as the boilers referred to are B. & W. marine type. He claimed that ⅔ of the tubes were warped; but he fails to state whether they were burnt or not, as I should think they would be. C. A. A.

A Troublesome Bearing

IN A RECENT ISSUE, a subscriber asked for the cause and remedy for a bearing throwing oil, and in the issues of April 1 and 15, several methods, including one by the writer, were given.

A few days ago, the main bearing of one of our high-speed 4-valve engines developed a case of oil throwing and began to lose oil at such a rate that during a 12-hr. run about 3 qt. of oil worked out of the bearing and most of it found its way under the flywheel into the generator pit. A close examination of the bearing while running, and also after shutting down, failed to disclose anything wrong, and at first I was afraid the frame was cracked. The next day, the main bearing was taken off, and also the top quarter box, thinking that possibly the oil grooves were stopped up; but we found them in good shape, and as good as new.

I did, however, find a little shred of waste about as large as a pencil and about 3 in. long, which had caught on the lower edge of the bearing cap (probably when wiping, the day before) in such a position that the oil thrown from the oil collar, and that working out of the end of the bearing followed the piece of waste down outside the bearing, behind the eccentric oil guard, and thus below the flywheel into the generator pit. No trouble of this kind has been experienced before or since on these engines, which proved to me beyond doubt that this little piece of waste was the sole cause of losing the oil. Its location was such that it easily escaped detection until the bearing cap was removed. Although the cause of loss of oil in this case was due to no fault of the bearing, it may prove of interest while this subject is still under discussion. J. H. CASE.

Operating Engine Condensing and Non-condensing

REGARDING operating with the same valve setting with and without vacuum, as discussed by G. R. and others, it all depends on why an engine runs noisy. If an engine is in perfect mechanical condition it will not pound without compression, with or without vacuum. If slightly out of condition, it may run quiet with compression of a certain degree and noisy with more or less. Some engines will pound with a certain load and run quiet with more or less.

Sometimes an engine will quiet if steam drops nearly to the point where the engine will drop speed. This is all due to mechanical trouble, and if any of them except compression will make it stop, it is recognized as a mechanical fault to be located and remedied; but if it runs noisy until given a lot of compression, it is said, "This engine needs compression." Nobody ever says, "This engine needs only 75 lb. of steam" or that an engine is overloaded if it pounds until ¾ load and runs O.K. with ½ load, and nobody ever yet gave a logical reason why an engine needed compression for quiet running, except that it is easier to quiet an engine by compression than to rectify its mechanical faults. An engine with valves set for noncondensing operation should run O.K. with a vacuum. An engine given all the compression it will stand condensing will slam its valves if run atmospheric. An engine should be in such condition that it will run with little enough compression to operate without vacuum and not slam the valves and with a vacuum and not pound. HARRY D. EVERETT.

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Purchasing Coal

With the constant increase in the price of coal, more attention should be paid to methods for reducing the annual fuel supply and cost in the power plant. Selecting the coal best suited to the boilers and then purchasing by contract according to specifications are matters which should receive the attention of every plant owner and operator. Too little attention has been paid to this item of operating expense, and yet this is the one item which in most plants can be reduced from 25 to 30 per cent.

How is it possible to determine the coal best adapted to the boilers? In the first place, boilers and settings should be properly proportioned for the kind of coal that is intended to be used. The area of grate, type of stoker if stokers are used, size of combustion chamber, and draft all enter into the problem of design. Lacking this information in the plant already installed, there is perhaps no better way of determining the most suitable coal than by conducting boiler tests under actual and normal operating conditions with a carload each of several kinds of coal. Boiler tests are fairly difficult to carry out successfully and accurately. Many plants lack the necessary instruments to take complete readings and frequently there is no one available in the plant who is capable of handling this kind of work. It will practically always pay, however, to employ a competent engineer to carry out a series of tests. In the majority of cases, the saving made will pay many times over the fee charged for the service and in any event, satisfactory records of operation are valuable for future reference.

By such tests, it is possible to decide upon a coal that is found to work well in the furnaces and which will give the greatest value for its cost. Once this is determined, the next step is to contract, if possible, for the annual supply to be delivered according to requirements. In submitting a carload for test purposes, the dealer will be asked to bid on the annual supply and he will make his lowest price in order to get this business. The operator must be reasonably certain of his yearly power load in order to be safe in contracting a given amount for the year.

An elaborate set of specifications for the purchase of coal cannot usually be carried out by the average plant operator; and, in fact, purchasing coal according to specifications without accompanying operative tests is rarely satisfactory. The average plant is not equipped to make analyses of coal samples. It is possible, however, to have a simple set of specifications covering items of moisture, ash, size of lump, and heat value. If these only are specified, it is not a difficult nor an expensive proposition to take samples from time to time and have them analyzed by a chemist or engineer.

As an example of what can be done in this line, a certain company had been purchasing its coal in the open market. The annual supply was about 2000 tons. After following the scheme suggested above, the saving for the first year was $1800, or about 30 per cent. In the last 5 yr., this company has saved nearly $7500 in coal alone. This saving was due to two things: First, the boiler tests showed up some serious losses in boiler operation which were corrected; also, the right kind of coal was selected and this, of course, helped out the fur-

nace operation. Second, the company was able to secure a much lower price by contracting for the year's supply. A simple set of specifications was used the first year, but the coal was found to run so uniform that the specifications were later omitted from the contract and only the kind of coal from a particular mine was specified. This method might not work out satisfactorily in all instances, but in this one case is entirely satisfactory to both parties.

Avoiding Defects in Plant Improvement

Power plant betterment work is many-sided, demanding a higher order of engineering insight and judgment for successful completion and improved service at lower unit cost than before the changes are inaugurated. We have no desire to throw cold water upon betterment practice in times like these, when station efficiency deserves the constant study of all operating engineers, and yet a few points may be mentioned from recent observation which are worth bearing in mind in the interests of all-around top-notch service.

There is a temptation in connection with plant reconstruction to resort to mixed layouts of equipment; for example, as in a water-power station recently visited where the older generating units are located on the floor of the operating room and the later machines are housed in the basement. Two-level operation in handling units supplying similar services—perhaps duplicate services—is a difficult matter from the standpoint of low labor cost per unit of output. Such an arrangement may be temporary, but its duration should be as short as possible on account of the handicap which it imposes in dealing with emergencies. It is a good thing to be able to *see* every generating unit in the plant from the switchboard or benchboard control desk. Wonderful equipment for remote control service has been developed in recent years. Such apparatus is likely to become more and more useful in the future, vitally necessary in many installations where high-voltage oil switches controlling transformers and lines requiring wide spacing arrangements are governed from a central point; but it may safely be taken for granted that the advantages of visibility will never yield in a land power station to mere flexibility of switch operation, so far as the generators and prime movers are concerned. Engine telegraphs and indicating instruments are invaluable in their place; but where visibility may be secured even at the cost of cutting away former floor levels, it is worth while.

In very small plants, the number of men employed per shift may drop down to one or two. These stations are sometimes rebuilt on a plan which transfers most of the switching equipment and perhaps the station auxiliary panels to a new gallery many feet above the floor and reached by a long flight of stairs or even by an iron ladder, to put the case at its worst possibilities. It is unnecessary to enlarge upon the extra labor forced upon the staff by some of these arrangements, and the very real temptation to operators to take inspection duties easily under such conditions. Along with this goes the mounting of separate belt-driven exciters in basement recesses well out of sight of the operating force in times of disaster, threatened or real. And finally, a little extra care in regard to exposed wiring and live contacts in spacing plant extensions or reconstruction work pays a very direct return in safety of operation. These and many other allied points go to emphasize the desirability of inviting the operating engineer into betterment conferences so that the benefit of his advice may be had in planning for improved equipment layouts.

Answers Required Immediately

In every power plant of this country, the answers to the following questions are demanded of the engineer today and every one of them is answered in this issue of Practical Engineer, the solutions being given by men of recognized ability in the power plant field and are based upon the most recent investigations.

Have you the most practical form of instrument on your boiler to guide your firemen in getting highest efficiency under varying load conditions?

Have you any means for determining, without a moment's delay, how much coal to burn per hour, thickness of fuel bed, drop in air pressure through the fuel, amount of air to supply to your furnace and flue gas temperature to carry for any load that may come upon your boiler? Mr. Phillips' method will apply to your plant.

Is your boiler breeching correct in design? Likewise, your damper and stack, according to standards set by Mr. Monnett? Right here is where you may find the cause of poor draft or smoke.

Why don't you have a centrifugal boiler feed pump?

Do your dynamo and motor brushes best fit your needs and are they adjusted properly?

Are any of the units, such as switchboard, potential regulators or storage battery, out of proportion in cost to the rest of your substation?

What kind of pipe joint did you specify for your refrigerating system? Did you leave that to the pipe fitter, then swear at him and everybody else because the joints gave trouble?

How did you bend that large pipe, and would you do it that way again?

How would you make a waste press to save oil and waste?

Is your U gage properly scaled and are you reading it correctly?

Have you read this issue so carefully that you know the answers?

Those Gardens

MOST ENGINEERS are making gardens this year, to help out the income and the food situation. The season has been backward in many parts of the country and there is more need to be sure that the ground is kept mellow, the weeds removed and the best conditions maintained for rapid growth.

Insects must be fought by spraying with Paris green or arsenate of lead and plant diseases by spraying with Bordeaux mixture, the strength for practically all vegetables being 5-5-50 and for fruit trees 3-3-50.

Those who know gardening should pass on information, and those who are novices ask for it. Neglect now means a lost crop and waste of labor and expense already put in.

Where radishes and onions are matured in early gardens, the space may well be planted to beans or turnips up to the time when there is any chance for crops to mature.

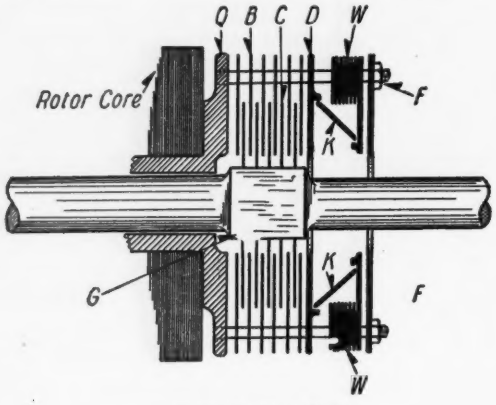
Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

Westinghouse C A Clutch

THE multiple-disc clutch developed by the Westinghouse Electric and Manufacturing Co. for its split-phase induction motors, has a number of advantages over the old type of clutch. A high starting torque is developed, the motor picks up to full speed under heavy and increasing loads, and a smooth acceleration of the driven machine is obtained, as well as overload protection for the starting winding. Centrifugal weights are used to operate the clutch as before; but instead of the weights themselves pressing against a drum, the friction between alternate plates of steel and phosphor bronze is used in locking the rotor to the shaft.

An idea of the method of operation can be obtained from reference to the accompanying figure. The weights are shown at W and fly out when a predetermined speed is reached. This compresses the plates through the toggle links, K, which force down the pressure disc,



Multiple Disc Clutch

CONSTRUCTION OF THE C A CLUTCH

D, against the alternate discs shown at B and C. The weights are normally pulled toward the shaft by springs which are omitted in the figure to prevent complication of the drawing. The rotor spider, Q, carries the phosphor bronze plates upon the studs, F, while the steel plates have square holes in the center which fit upon the square portion of the shaft shown at G; thus, one set of plates must turn with the rotor, while the other set must turn with the shaft.

The clutch is rugged in every detail and is positive in operation, the toggle links multiplying the forces of the weights upon the friction plates.

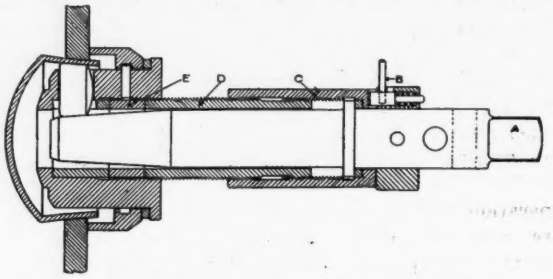
Weights and springs are so adjusted on both the clutch and the switch, used to open the starting winding, that when the motor is operating, the switch must open before the clutch starts the shaft. When the motor is retarded by an overload, the clutch will slip before the starting winding circuit can be closed. This gives absolute protection against burnout to the starting winding.

Slots are cut in the friction discs to prevent warping when one portion becomes heated more than another, and they also assist in clearing the clutch of oil and dirt. The discs are arranged so that they can be easily replaced should they become scored or burned due to prolonged overload, but in no way can the operating mechanism be harmed.

The split-phase motor equipped with this clutch gives the highest starting torque that can be obtained from a split-phase motor, and it will bring up to speed any load it can start.

Key Safety Handhole Caps

BOILER operators are, as a rule, compelled to tolerate much annoyance and trouble due to leaky handhole gaskets, which may, however, now be entirely eliminated by substituting Key Safety Handhole Caps, recently placed on the market by the Key Boiler Equipment Co., Pierce Bldg., St. Louis, Mo. These caps making a metal to metal fit will remain tight indefinitely, and due to the fact that they are inserted from inside



KEY SAFETY HANDHOLE CAP AND SETTING TOOL

the water leg, the steam pressure acts against the back of the cap, holding it to its seat similar to a check valve. They may be removed and replaced at will and are practically indestructible.

In applying the caps, the edges of the handholes and the outer surface of the water leg sheet should first be well cleaned of corrosion and scale, after which the holes are made to a standard size by revolving special rollers furnished with the caps.

The tool employed for this purpose, illustrated herewith, is inserted in the hole and feed nut (C) screwed up until all slack is taken up. Locking device (B) is then engaged with feed nut (C) and expander pin (A) turned until this nut jams against the body of the expander when locking device (B) is disengaged and expander pin (A) is given three full turns. The holes are then of standard size and shape and ready to receive

the caps, the bearing surfaces of which, the same as that of the hole, should be coated with a mixture of graphite and raw linseed oil mixed to the consistency of a paste. The cap is then driven into the hole from the inside of the water leg with a lead weight and the expander inserted in the cap and feed nut (C) screwed up until all slack is taken up. Locking device (B) is then engaged and expander pin (A) turned until a pressure has been exerted sufficient to force the walls of the cap in intimate contact with the side of the hole. Then locking device (B) is disengaged, expander pin (A) given three turns and locking device (B) re-engaged and backed out by turning to the left.

In changing expander to tighten caps, screw out stud (D) and insert ring (E), screw stud (D) down on ring (E) and turn back feed nut (C) until the tool will enter the cap.

Honors First National President of the N. A. S. E.

NEW JERSEY No. 3, Newark, National Association of Stationary Engineers, recently celebrated in honor of Henry D. Cozens, the first National President of the National Association of Stationary Engineers and a member of Newark No. 3 Association, by unveiling a large picture of Mr. Cozens, inclosed, with the preamble of the association engraved, in a beautiful mission frame. Quite some time previous to the unveiling of the picture, Newark Association was honored by a visit from Fred W. Raven, National Secretary of the Association; Henry J. Mistele, of the Association's Board of Directors, and Joseph O'Connell, also of the Board. At the time, Mr. Raven presented Mr. Cozens with a national president's badge. It was on this occasion that the Association decided to have a large picture of the first national president made and hung in its hall.

Charles H. Bromley, Instructor for Newark Association, in unveiling the picture, spoke in part as follows: "The preamble today is as it was written by Cozens nearly 35 yr. ago. As the years go on, and as the requirements of the operating engineer become more complex and more technical, we will have a deeper appreciation of the value of the Association as Mr. Cozens conceived it, and as it has been developed by others who have followed him. More and more conditions in the field of power plant engineering prove that the aims of this association, as laid down in the preamble, viz., that, 'This Association shall at no time be used for the furtherance of strikes. . . . Neither shall it be used for political or religious purposes. At all times preference shall be given to the education of engineers and to securing the enactment of engineer's license laws . . .' are sound.

"One need not go into details to convince his hearers that the greater efficiency in industry demanded by the astounding advances in the industrial arts and the plans now being arranged for competition for world trade after the war, will call upon the power plant man to produce his best, with comparatively little time to prepare. Organization is what will do this quickest. That we have. Let every man do his best to make the organization work for him in giving him the training he will need."

Mr. Bromley urged every association in the national body to have hanging in its reading room a duplicate of the picture of the distinguished first national president.

The Association has made arrangements to provide these to associations that want them at a cost of $6 each. The picture is shown herewith. Address Joseph G. Fischer, secretary, 104 Branford, Pl., Newark, N. J.

Mr. Cozens spoke of the early history of the association. Having its beginning in the Providence Association of Stationary Engineers, organized December, 1879, the creation of a national association of engineers was, Mr. Cozens believed, a big way to meet a big need. Thereupon many engineers about the country were asked to join the movement. Brooklyn, N. Y., was first to respond, then Chicago, Detroit, Rochester, Boston, New

York, Philadelphia, followed in the order named. The first convention was called to order by Mr. Cozens in Lithographers Hall, New York City. In his address, Mr. Cozens read the preamble he had prepared, and which is the same as is used today.

Chris Holden, then Sheriff of Providence County, R. I., allowed Mr. Cozens, who was then subordinate to Holden, to visit cities and organize associations. In 1883, Mr. Cozens went to the staff of the Boston Journal of Commerce and while with that paper traveled the Atlantic States, which gave him an opportunity to organize many associations. In the meantime, Mr. Alonzo, of Detroit, and Messrs. Beckerleg and Davy, of Chicago, were active organizing in the Middle West.

Not knowing its purposes, employers feared the or-

ganization would give labor trouble, and were, therefore, not favorably disposed toward it. To avoid this, the services of George H. Corliss, inventor of the Corliss engine, Channing Whittaker, of the Massachusetts Institute of Technology, Wm. A. Harris, of the Harris-Corliss Engine Works, Z. Allen, inventor, and Fred R. Low, editor, were gladly given. Many employers and mill superintendents attended the addresses made by these men. Among those early lecturing to the association were George Dimon, well known as the chief engineer of the famous Amoskeag Mills, and Thomas Spray, remembered for his early lectures on the indicator.

A First-Aid-to-the-Injured class, organized and instructed by James C. Savage, chief operating engineer for the Clark Thread Co., and a member of the Newark Association, was recently graduated in the association rooms. The graduating class numbered 13 members of the association. This is the first association to organize first aid classes; the members are also members of the American Red Cross.

News Notes

A. W. PATTERSON, JR., formerly with Yale & Towne, has become vice-president and sales manager for The Engineer Co., 17 Battery Place, New York.

G. E. LAND, recently with the advertising department of the National Tube Co., has been appointed as advertising manager of Blaw Steel Construction Co., of Pittsburgh, Pa.

C. A. NEWMAN, formerly manager of sales promotion for Henion & Hubbell, has accepted an appointment as sales manager of The Boiler-Kote Co., with offices in the Fisher Bldg., Chicago.

THE PUMP AND ENGINE business of the Erie Pump & Equipment Co. will hereafter be handled by the Erie Pump & Engine Works, of Medina, N. Y., and the Copes feed water regulator and pump governor business by the Northern Equipment Co., Erie, Pa., a change necessitated by the large increase in business. Correspondence should be addressed as indicated above.

UNITED POWER & FURNACE CO. has been formed as an Illinois corporation, with offices at 208 S. La Salle St., Chicago, to design and construct powdered coal installations, metallurgical and special furnaces, steam power plants, pumping stations, and all apparatus for economical burning of fuel. The officers of the new corporation are, Joseph Harrington, president; Carl Heim, secretary and treasurer; Wm. A. Nelson, vice-president and general manager.

A. A. GRAY, formerly managing editor of the Electrical Review, and at present president of the Associated Business Papers, and Chas. L. Benjamin, for 9 yr. advertising manager of the Cutler-Hammer Mfg. Co., and later advertising counsel on machinery products, have formed the firm of Gray & Benjamin, 301 Transportation Bldg., Chicago, to specialize on problems of manufacture and distribution of mechanical and electrical products, with the object of eliminating waste in advertising effort and expenditure.

AT MEETINGS of the Westinghouse Electric & Mfg. Co. and of the Westinghouse Machine Co., held in East Pittsburgh, June 13, it was unanimously voted to merge the two companies, and directors and officers were empowered to arrange for the execution of the merger. Directors of the Electric & Mfg. Co. were reelected for four years, as follows: J. D. Callery, Paul D. Cravath, Harrison Nesbit and James N. Wallace; and for the Machine Co. the following were reelected for one year: J. D. Callery, E. M. Herr, H. T. Herr, Wm. McConway, John R. McCune, Jos. W. Marsh, L. A. Osborne, Guy E. Tripp and H. H. Westinghouse.

THE FOLLOWING U. S. Civil Service examinations are announced for July 11: Junior drainage engineer, entrance salaries ranging from $1080 to $1320 a year; assistant physicist, $1500 to $1800; mechanical laboratorian, $4.24 a day.

U. S. CIVIL SERVICE COMMISSION announces examinations as follows, applications to be received at any time: Assistant inspector of engineering material, at entrance salaries of $4 to $4.48 a day; assistant physicist, $1400 to $1800 a year, and associate physicist, $2000 to $2800.

Book Reviews

WIRING FOR LIGHT AND POWER, by Terrell Croft; 426 pages, 382 illustrations; first edition; New York, 1917. Price, $2.

While the National Electrical Code, frequently referred to as the "wireman's bible," explicitly states what shall and what shall not be done in matters pertaining to the installation of electric wiring and electric apparatus and appliances, no elaborations or explanations are embodied therein to serve as a working guide for the practical man. Its principal function is to specify wiring and installation methods which will minimize fire hazard and at the same time be economically feasible. This is a wide field and therefore the rules of the Code should necessarily be, and are, in many cases, very concise.

The purpose, then, of this book, as stated by the author in his preface, is to supply explanations, elaborations, and illustrations for those sections of the National Electrical Code to which those having to do with the installation and maintenance of electrical equipment have occasion to refer most frequently. The regulations or rulings considered and their application to electrical construction work are comprehensively explained and illustrated wherever such illustrations might prove of assistance. Where such explanations are feasible and available, the reasons for the adoption of the Code rules are discussed.

Like the Code, the subject matter contained in this volume is divided into Classes from A to F inclusive, bearing the following respective titles: Generators, Motors, Switchboards, etc.; Outside Work. All Systems and Voltages; Inside Work. General Rules, All Systems and Voltages; Fittings, Materials and Details of Construction, All Systems and Voltages; Miscellaneous; and Marine Work. Each subdivision of the various classes is introduced by a verbatim recitation of the more important portions of the 1915 National Electrical Code on the particular subject under consideration; this is then

followed in large type by the author's comments and explanations and illustrations where these may be of assistance.

In general, this volume, while devoted to a field already well covered by texts on the subject, possesses many exclusive features not found in other books and should surely fulfill a long felt requirement on the part of electricians, wiremen, contractors, electrical inspectors, engineers, etc.

STORAGE BATTERIES SIMPLIFIED, by Victor W. Page; 208 pages, 89 illustrations; first edition; New York, 1917. Price, $1.50.

Due to the rapid development and ever widening application of the storage battery, there has naturally been created a demand for some comprehensive non-technical treatise on the subject, especially one to meet the needs of the practical man. It is for this reason this book has been prepared.

Chapters I and II are devoted to discussions of the theory of the storage battery in general and descriptions of the details of the various types and makes of cells. This portion of the book is quite elementary in nature but will undoubtedly prove valuable to the man having little or no knowledge of batteries.

Defects and troubles ordinarily encountered in the operation of storage batteries, together with their remedies, are taken up thoroughly in the third chapter. Of particular value are the explicit directions given for the repair of the more prominent makes of batteries and the section devoted to the subjects of lead burning and lead-burning outfits. Charging methods and descriptions of the apparatus employed for this purpose are taken up in Chapter IV.

Application of the storage battery is discussed in the fifth chapter; the following and concluding chapter is devoted to a glossary of storage battery terms.

Much of the material in this book has been obtained from literature issued by the manufacturers of the more prominent makes of batteries, rendering the book a more authoritative and valuable treatise than would otherwise be possible. As the experience of these leading authorities on all phases of storage battery engineering is condensed and digested, all the information that the average reader needs may be obtained without consulting a mass of literature.

PRELIMINARY MATHEMATICS, by F. E. Austin; cloth, 169 pages, illustrated; first edition, 1917, Hanover, N. H.; price, $1.20.

This book, which has apparently been written by one who thoroughly realizes the needs of those of limited educational training, should not only meet the requirements of grammar and high school students as a connecting link between the study of arithmetic and that of algebra, but should also prove of considerable value to those more mature students whose early education has been more or less neglected. It consists of Parts I and II, the former suitable for pupils in the eighth grade and below, and the latter for those attending high schools and academies.

Divisions of subject matter are more properly referred to as lessons than chapters, each such lesson taking up some particular phase of the work in a thorough and comprehensive manner, supplemented by examples illustrating to the student the application of the preceding discussion. Numerous problems are then given for solution, blank spaces being left for this work throughout the book.

Of particular value to those preparing to meet university entrance requirements should be the lists of typical algebra examination questions and solutions found in the last few pages.

LUBRICATING ENGINEER'S HANDBOOK, by John Rome Battle; illustrated, 333 pages, 6 by 9 in.; Philadelphia, 1916. Price, $4.

In this book, lubricating engineers, oil salesmen, operating engineers, mill and power plant superintendents and machinery designers will find data, tables and general information which will aid them not only in the selection of lubricants but in the design of bearings, oiling systems, oil handling equipment, etc. The book is divided into 5 parts. Part I consists of 5 chapters in which are considered friction, theory of lubrication, the history of petroleum, oils, other lubricants and greases. Part II consists of 4 chapters, two of which are devoted to oil data and miscellaneous notes, mechanical and lubricating engineering data, another chapter describes steam engines and turbines and another gives electrical engineering data. Part III has 5 chapters, all devoted to bearing lubrication, all types of bearings and methods of feeding being considered. Part IV takes up the discussion of lubrication of various special machines as used in different industries, 21 chapters being devoted to this subject. Part V contains a chapter on the cost of lubrication and another on specifications. The book is well illustrated throughout, thoroughly indexed and is so complete that it may be used as a text book as well as a convenient reference book upon the subject of lubrication.

Catalog Notes

A RECENT CIRCULAR of the Society for Electrical Development announces a "Keep Business Going" campaign. In an important letter, H. L. Doherty, president of the Society, urges the laying aside of petty jealousies, and concentrating on efforts to find new ways to serve the public and the government.

Possibilities suggested are electric light to protect bridges, munition plants, waterways and workshops; electrical apparatus to increase the effectiveness of labor on farms, in homes and in shops; education of users of current as to the importance and value of devices which are proving to be helps and necessities rather than luxuries.

A book has been prepared giving a list of 3000 applications of electricity for various industries which will result in economy of time, money and labor. A copy of the folder containing a list of the business helping books will be sent to any person in the industry who writes to J. M. Wakeman, general manager, 29 West 39th St., New York City, asking for it.

BULLETIN NO. 177, superseding Bulletin No. 128, of Crocker-Wheeler Co., Ampere, N. J., describes Form W rolling-mill motors, used for cranes, roll trains, transfer and lifting tables and all auxiliary service about a steel mill.

Bulletin No. 178, superseding Bulletin 144, discusses

the relative values of the various methods employed for obtaining 3-wire distribution of direct-current energy, and illustrates the company's 3-wire rotary balancer system and 3-wire generators.

LINK-BELT CO.'S new booklet, No. 253, entitled, The Ideal Drive for Cement Mills, describes the large Link-Belt Silent Chain Drive installation at the plant of the Nazareth Cement Co., at Nazareth, Pa.

GENERAL ELECTRIC bulletins have been received as follows: Nos. 47,474 and 47,475, on oil circuit breakers for use on systems of large capacity; Nos. 47,476 and 47,477, on oil circuit breakers for outdoor service on systems of large capacity; Bulletin 47,100, Safety First, Truck Type, A. C. Switchboard Panel Units, 240 to 6600 v., 25 to 60 cycles, 3-phase, 3-wire, for general feeder and distribution service; No. 46,208, Single-Phase Prepayment Watthour Meter Type IP-5.

Trade Notes

COMBUSTION ENGINEERING CORPORATION, 11 Broadway, New York City, has secured a total of $6000 in subscriptions to the Liberty Loan throughout the organization by means of a special plan whereby the employes have purchased these bonds through the company. Over 50 per cent of the employes have subscribed amounts ranging from $50 to $1000.

RAPIDLY GROWING BUSINESS in New York territory has forced the Sims Co., whose factory and head office are at Erie, Pa., to remove the New York office from the Marbridge Bldg. to the 10th floor at 90 West St., New York City. All New York and export business will be handled from the new office, under the management of the General Sales Agency, W. B. Connor, Inc.

EVERY OFFICER AND EMPLOYE of the Economy Fuse and Manufacturing Co., Chicago, has done his or her bit for liberty. Every name on the payroll stands for some personal service or personal sacrifice for the cause. Every member of the organization, numbering over 200, has purchased one or more Liberty Bonds, from the officers and directors to the newest office boy. Some of the men and women have gone to the front in the army, the navy, the marines, and in ambulance units. The stay-at-homes have responded to the government's appeal by subscribing a total of $80,000 worth of Liberty Bonds.

NATIONAL ACME CO., of Cleveland, Ohio, has just placed an order with Buffalo Forge Co. for heating and ventilating equipment. This installation will be the largest of its kind in a building under one roof and ventilated by the fan system. The equipment consists of four Carrier type "A" air washers with automatic control, and fresh and return air dampers; four Niagara Conoidal supply fans, two of which deliver 100,000 cu. ft. of air per minute each; and two 95,000 cu. ft. of air per minute each; four exhaust fans, two of which will handle 70,000 cu. ft. of air each, and two 50,000 cu. ft. of air per minute each; 10 Baby Conoidal fans for toilets, 27,000 sq. ft. of Vento, and four 12 by 14-in. steam engines for driving the fans. Geo. S. Rider & Co. are consulting engineers.

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Advertisements in this section are inserted under regular headings.

No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 22,000.

Technical Publishing Co.

537 S. Dearborn Street

Chicago

Position Wanted

POSITION WANTED—By man 33 years of age, good habits, with 6 years' experience with steam and gas engineering. Best of reference. Ohio license. Would prefer position in western or southern states. Address Box 482, Practical Engineer, 537 S. Dearborn St., Chicago. 7-1-1

POSITION WANTED—As chief engineer. Have had 10 years' practical experience. Especially qualified to handle the plant on an efficiency basis, reducing coal consumption and operating costs. Must locate in Chicago. Presently employed, but have good reasons for desiring a change. Address Box 479, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 6-1-1

POSITION WANTED—By steamfitter with 17 years' experience at the trade. Can furnish references as to habits and ability to handle men. I am 33 years old. Married. Address J. H. D., 669 Wunderlick St., Barberton, O. 6-15-1

POSITION WANTED—By thoroughly competent man with 11 years' experience as engineer and assistant superintendent in sugar factories in Cuba, Mexico and Louisiana. Good steamfitter and machine repairman. Have had charge of 10 steam boilers and 6 ammonia compressors as day and night engineer. Can speak English, Spanish and some German. Single. 26 years old. Can furnish good references. Address Box 480, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 6-1-2

POSITION WANTED—Fireman with first-class Mass. license would like to locate near Boston, Mass. Day work, 8 or 10-hour day. Sober and reliable. Best of references. Address R. C., 17 Cozenore St., Boston, Mass.

POSITION WANTED—By engineer competent to operate Corliss and high speed engines and turbines. Familiar with a.c. and d.c. generators and refrigeration. Age 27. Married. Sober. Desire position around New York. Address A. Kahel, 233 S. 4th St., Brooklyn, N. Y.

POSITION WANTED—By man 30 years old, good habits, married, with 6 years' experience in steam electric plants. Would like position as engineer in plant of 2500 kw. capacity or more, where I can advance myself. Address Box 471, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 6-1-2

POSITION WANTED—Young man, age 28, as engineer in New York or Brooklyn. Hold marine, stationary and refrigeration license. Day work, 8-10 hours, desires to go to school nights. Write for particulars. Box 452, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 5-1-4

POSITION WANTED—As oiler, by young man, age 21, single. Willing to accept position in any city. Address Peter Stanys, 670 W. 18th St., Chicago, Ill. 6-1-1

POSITION WANTED—As fireman or oiler in large plant; 3 years' experience as fireman, 18 months as assistant engineer. Married. Strictly sober. Prefer Southern States. L. C. Drake, Cambridge City, Ind. 6-15-1

POSITION WANTED—as chief engineer in industrial plant, Missouri, Arkansas, Kansas, Iowa or Nebraska, or as Superintendent of light and water plant in city of 2500 to 8000. Ten years' practical experience with steam, electrical and water systems. Technical training. Now employed by U. S. Government as engineer and instructor. Executive ability. Can report on 15 to 30 days' notice. Married. Age 30. Address Practical Engineer, Box 466, 537 S. Dearborn St., Chicago, Ill. 6-1-1

POSITION WANTED—By young man, 23 yrs. old, as fireman or oiler in ice and electric light plant in City of St. Louis. Have had one year's experience in firing and some experience in steam engineering. Address Leonard Ochs, 1536 Papin St., St. Louis, Mo. 6-1-2

POSITION WANTED—As engineer in small power plant. Five years' experience as engineer in grain elevator. Good mechanic. Steady and sober habits. Single. 28 years old. Central states preferred. Box 115, Walcott, Iowa. 5-15-3

POSITION WANTED—By engineer; have Ohio engineers' and boiler inspectors' licenses. Experienced with absorption method of manufacturing gasoline. Good references. Address Box 481. Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 6-1-2

Help Wanted

WANTED—Resident subscription agents in the following cities: Atlanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Cal.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Cal.; Washington, D. C. This is an excellent chance for a hustler who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. tf.

Wanted

WANTED—Agents on commission to sell our shaking grates. We will install grates on trial or put it to test at our expense with any grate made. Address Armstrong Mfg. Co., Springfield, Ohio. tf.

WANTED—Agents handling engine and boiler room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Box 381, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. tf.

For Sale

FOR SALE—75 Kw. G. E. 125-250 volt 3-wire generator, dir. con. Buckeye side-crank engine, like new, $1,250. Two 40 Kw. G. E. 125 volt belted generators, $300 each; 13x13 Chuse automatic engine, $300. Power Machinery Exchange, Jersey City, N. J.

WANTED—Marine boilers. We will pay cash awards for information that leads to a purchase by us of marine boilers of from 75 H. P. to 250 H. P. The Pittsburg Boiler & Machine Co., Pittsburg, Kansas. tf

Patent and Patent Attorneys

PATENTS THAT PROTECT AND PAY—Advice and books free. High references. Best results. Promptness assured. Send sketch or model for search. WATSON E. COLEMAN, Patent Lawyer, 624 F St., N. W., Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had and the exact costs. Send for full information. tf.

A. P. CONNOR, Consulting Electrical and Mechanical Engineer, Attorney-at-Law and Solicitor of Patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C. tf.

PATENTS—Send sketch for free search and reports. Books and patents and book of reference letters sent free. John S. Duffie & Co., 612 F St., Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Technical Books

FREE ENGINEER BOOKS and power plant tools and specialties, for securing new subscribers for Practical Engineer. A dandy chance for the engineer with a little spare time to get some fine premiums. Send for free descriptive circular and terms. Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago, Ill.

Miscellaneous

ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes without back pressure on your engine? If so, address Monash Engineering Co., 1413 Jackson Blvd., Chicago, Ill. tf.

Sparks From The Advertising Pages

Men, Methods, Materials

"Efficiency and a greater production," is the industrial slogan of the hour.

There will be big demands on the power plant this fall. This, naturally, means that the power plant should be in a state of preparedness. The world or at least the major part of it has been turned topsy-turvy politically—it is undergoing an acute change industrially. Manufacturing will be done more intensively from now on. Production will be the vital problem—already many manufacturers are realizing its seriousness.

The problem of finding markets has given way to the problem of filling orders. Short cuts will be resorted to—wastes must be eliminated. Efficiency will come into its own. He will be most patriotic who can give the greatest service with the least amount of energy expended. This includes all men in the industrial world—he who actually produces—he who contributes toward production—and he who oversees production.

Men of the power plant, heed this call to patriotism. The industrial world cannot be assured of a steady increase in production without an efficient power plant and an efficient power plant staff. Your plant must be operated day in and day out, week after week without interruption and to do this it must be properly equipped—no inefficient machine or device should be allowed to remain in service. **Now** is the right time to look over your plant—dismantle any part that comes under the ban of inefficiency—and install equipment that will keep your plant going at top notch as long as you want it to.

For the sake of your country—for the sake of your own personal interests—don't hesitate to spend money for equipment that will promote efficiency and a greater production. Don't hoard your money. Hoarding is not economy—it contributes largely to those psychological depressions which so often preceded acute national and international crisis.

Many of you will not be called upon to shoulder a musket but you will be expected to shoulder the additional responsibilities resulting from these conditions—this is patriotism—without glory to be sure—but with a lot of satisfaction in the knowledge that you have done your "bit."

Eliminate waste—promote efficiency—speed up production—buy wisely and from the advertisements, for they alone can assure safety and economy in buying. Then and then only will our nation be victorious in its supreme struggle.